NATIONAL CRITICAL MATERIALS COUNCIL

HEARING

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

FIRST SESSION

MARCH 31, 1987

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**Resigned February 19, 1987 (H. Res. 89).
***Elected March 30, 1987 (H. Res. 133).

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NATIONAL CRITICAL MATERIALS COUNCIL

TUESDAY, MARCH 31, 1987

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS,

Washington, DC.

The subcommittee met, pursuant to call, at 2:20 p.m., in room 2325, Rayburn House Office Building, Hon. Dave McCurdy (chairman of the subcommittee) presiding.

Mr. MCCURDY. Good afternoon.

This committee initiated the legislation that ultimately led to establishment of the National Critical Materials Council. The law creating the Council was signed by the President over two years ago. Yet, we have seen no real action to implement the key provisions of that Act. These include the requirements for a report to access—to assess the long-range needs of critical materials and the establishment of a national Federal program plan for advanced materials research and development.

The long-range assessment on national critical material needs was due April 1, 1985. We are now exactly two years behind in producing that report. Meanwhile the problems remain, including such areas as stockpile management and goal setting; South African policy regarding critical materials; the decline of our domestic based metals and mining industry; and the increasing competitiveness in the international marketplace for advanced materials.

With regard to a program plan for advanced materials research and development, we have seen no discernible progress in establishing that plan. This is despite the—in spite of the requirement for annual revision and coordination with the more than $1.5 billion Federal materials R&D budget.

Our committee, through various hearings, reports and assessments, has identified three critical advanced materials areas requiring attention. These are structural ceramics, advanced composites and rapidly solidified alloys. These materials are strategically and economically vital to such programs as the Aerospace Plane, the Space Station, and SDI. Meanwhile, Japan and Europe and others continue to invest in these critical, enabling technologies through well articulated, well thought-out national programs with the goal to dominate the economic markets of the next century. I believe we can ill afford to tary further to—in organizing our own programs in these critical materials. Frankly, I am puzzled as to why we have done so little to implement this important law.

We will be hearing first from the Chairman of the Council, Secretary of the Interior, Donald Hodel. Hopefully, he can help answer

that and other questions. As well, representatives of the Department of Defense and industry will testify. I am sure they will provide us with further useful information on this vital subject. And I look forward to hearing all of their views.

I understand that Mr. Lewis will be joining us shortly, and with that we will commence with Secretary Hodel's statement.

STATEMENT OF HON. DONALD PAUL HODEL, SECRETARY, DEPARTMENT OF THE INTERIOR, AND CHAIRMAN, NATIONAL CRITICAL MATERIALS COUNCIL, ON BEHALF OF THE NATIONAL CRITICAL MATERIALS COUNCIL, ACCOMPANIED BY BRIEN BENSON, EXECUTIVE DIRECTOR, NATIONAL CRITICAL MATERIALS COUNCIL

Secretary HODEL. Thank you, Mr. Chairman. I have a prepared statement, which, with your permission, I would like to have entered in the record.

Mr. MCCURDY. Your statement will be entered into the record and we look forward to your summary.

Secretary HODEL. I'd like to summarize just as briefly as I can. This is my first appearance in this somewhat different role as chairman of the NCMC. I am struck by the similarities that I am aware of between the problems confronting the critical materials and domestic minerals industry and the domestic energy industries, where I have had considerably more experience and exposure.

But what I am aware of is that the recent report of the Secretary of Energy, Secretary Herrington, which identifies what's happening to us in the energy area has become an important bench mark as we try to come to grips with how this Nation is going to deal with its energy requirements. Secretary Herrington made the point, I think very effectively, that in his view that report shows that we have a problem in the energy field and something needs to be done about it.

I think honest men will differ as to what precisely ought to be done about it, but at least the debate will be over the right question, that is what should be done, as distinguished from whether or not there is even a problem.

I see the similarity here when I look at the National Critical Materials Council because I find much the same kind of unawareness of problems in the areas we are talking about here when I talk to people broadly that I have found for the last year and a half or longer when we talked to people about potential growing problems in the energy field.

So I—as I say, I feel the context is quite similar.

As you know, Dr. Tom Moore, who is a member of the Council of Economic Advisers, is one of the other three members of this Council; and Deputy Secretary of Energy Bill Martin joined the Council when I did about four months ago.

The—I have requested that our newest Assistant Secretary, Jim Ziglar, who is with me today, but I cannot pass any burdens to him today yet because he was sworn in just yesterday—but I have asked him to serve as my, if I can put it, the liaison or ramrod with the Council and its staff, particularly because he has under him

the U.S. Geological Survey and the Bureau of Mines in the Department of Interior, which are very substantial resource bases for much of the information that needs to be dealt with by the Council.

We also have retained a former Deputy Assistant Secretary of Interior as a consultant to assist us in finalizing our Critical Materials Report. And we have from the Department of Energy a senior policy analyst, Ted Harris, to serve as the—as Bill Martin's liaison to the Council and to the staff.

When I look at critical materials I see their relevance in an economic pyramid. I look at the pyramid, I see at the base of the pyramid in this country extractive activities in energy and minerals and agriculture. And to look across the country I see very grave difficulties in various categories relating to all of these.

We move up the lad—up the pyramid, the next layer may be heavy industrial and then light industrial, and high technology, and on up the chain until we come to services at the very top of the pyramid. But my view is that the strength and stability of that pyramid is dependent upon the strength and the stability of the foundation. If that foundation isn't strong, I fear that many of the other economic activities and then in turn our national security activities, which are dependent upon a solid economic base, are in trouble.

When we arrived at the Council, we, of course, went through what I suppose each new set of arrivals have to do, and that is determine what is our role going to be. It appeared to us as we read the statute that the role the Council had to try to play would serve as a leader—in a leadership role, not any direct hands-on management. As we looked around the Federal Government and saw all of the various departments that are doing things in these various categories, it was clear that the Department of Defense and the Department of Energy, Department of Interior, are not going to defer to an outside manager, but would be amenable—in our estimation—to an appropriate effort to coordinate and provide some—some leadership in the various areas of their activity that affect this Council.

The two reports seem to us to be critical next steps, and I am, frankly, disappointed that we do not have at this time the draft of the Critical Materials Report to present to the Council—to this committee. I hope that that will be fairly soon.

The other report, of course, is the Advanced Materials Program Plan that you referred to, Mr. Chairman, in your opening statement.

In January, the Council met and approved the—the production of these reports.

The Critical Materials Report, in our view, needs to be a dynamic—at least initially—needs to be a dynamic document. And what we have visualized is the—is the preparation of a document containing a—an initial chapter with cross-cutting issues that reach across the whole range of problems that are inherent in that area.

But we think that the second section of it, then, would consist of a series of individual sections on each of the critical materials that are dealt with. And we have identified for the first go-round some of those that are spelled out in the Report—the very obvious ones: the copper, aluminum, cobalt, chromium, and so forth, that we

think need to be cataloged. And our theory—our proposal would be that with that draft report that it will be disseminated and that especially in the first go-round there will be many things that we have not included that experts in the field will promptly identify and will suggest an expansion or an alteration of what we have supplied.

In looseleaf format, we believe it will permit us to send out updated or revised pages or paragraphs as appropriate, or sections, rather than having to wait until you figure there are enough changes to print a new report a year from now.

Our sense is that this is a dynamic area and we ought not to be waiting 12 months between making changes that are necessary to communicate effectively.

One of the cross-cutting concerns that we deal with is, of course, the problem of imports and the worrisome aspect that some of the more significant imports come from areas that are not secure sources.

The Advanced Materials R&D Program Plan, which we will pull together, will be pursuant to first attempting to identify what is going on in each of the departments. We have written Defense, NASA, National Science Foundation, National Bureau of Standards, of course, Interior, and Energy. And we will be talking to the Science Adviser to the President when we pull that material together to try to provide some kind of useful, meaningful analysis of what it is that's going on.

Each of these departments has its own focus and its own attention directed to particular areas of its concern but my perception is that Congress and the administration are both interested in finding out whether there are additional fits or matches of what can be done.

We pursue—we will pursue technology transfer—that is something that is not only statutorily mandated in the country—and I was familiar with this when I served as Secretary of Energy. The National Laboratories had a major effort. It takes constant—constant tending to accomplish, but there's the major effort to provide for technology transfer. It's not good enough to achieve some important breakthrough in a laboratory, but being satisfied with that, simply say that's all we need to do with it. It's important to try to find a way how that can be converted then into—into effective results.

My opening statement lists a series of things that staff has undertaken since our last meeting and some of the things we have requested from Admiral Mott's Committee, but I will not take the time here to go into those.

Our central theme for the Council is the health and competitiveness of the domestic mining and materials industry and their importance to our national security. And I hope that as a result of the work that we have begun and we are continuing we can make a real contribution to improving all of them.

[The prepared statement of Secretary Hodel follows:]

TESTIMONY OF DONALD PAUL HODEL

CHAIRMAN, NATIONAL CRITICAL MATERIALS COUNCIL
EXECUTIVE OFFICE OF THE PRESIDENT
BEFORE THE
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
MARCH 31, 1987

Mr. Chairman, I appreciate the opportunity to discuss with you the objectives and activities of the National Critical Materials Council, of which I became Chairman in November.

Let me say first that it is a pleasure to have as my fellow Council members Deputy Secretary of Energy William Martin and Council of Economic Advisers member Dr. Thomas Moore. Mr. Martin, who joined the Council only four months ago, as I did, brings not only an impressive background in national security issues -- from his tenure as Executive Secretary of the National Security Council and current work on energy security -- but also experience with the full range of advanced materials issues at the Department of Energy. And Dr. Moore, who testified before this subcommittee last year as Acting Chairman, has an outstanding reputation as an economist, with the ability to focus Council of Economic Advisers staff attention on any key economic issues we might confront. Our diverse perspectives already have interacted to chart a positive course of future activity for the Council.

I also am pleased to announce that James W. Ziglar, who was just confirmed as Assistant Secretary of Interior for Water and Science, will serve as my personal representative to the Council -- a key assignment that I felt should be given to a senior policy official. In addition to representing my policy perspectives, Mr. Ziglar in his capacity as my Science Advisor, oversees both the Bureau of Mines and the United States Geological Survey, and will ensure that all resources of both organizations will be available to assist the Council in accomplishing its mission. Mr. Ziglar also is my representative to the National Strategic Materials and Minerals Program Advisory Committee (Mott Committee), which has provided immensely valuable advice to me on strategic minerals issues, and which has worked closely on these issues with the Council since its inception. I should point out also that, as Assistant Secretary for Water and Science, Mr. Ziglar succeeds a former National Critical Materials Council member, Bob Broadbent.

We have hired as a consultant Mr. Perry Pendley, a former Deputy Assistant Secretary at the Department of the Interior, who has extensive knowledge of critical materials issues. Mr. Pendley is engaged currently in finalizing our Critical Materials Report.

We are pleased also that the Department of Energy has designated a senior policy analyst, Ted Harris, as liaison to the Council.

When I became Chairman of the Council four months ago, I met with a large group of industry, academic and trade association officials to help chart a path for the Council. The meeting was of great value, and brought forth a wide diversity of perspectives. Discussion ranged from economic health and competitiveness of American industry, to the National Defense Stockpile, to the need for education and greater public awareness of materials and minerals issues. During that meeting we began to frame the Council's thinking about its direction. Since then I have continued to visit with public and private sector leaders to develop further our thinking about the Council's direction.

The Council members and I recognize the critical importance of minerals and materials to the Nation's economic health and military security. We must be sensitive to those policies and programs which could have adverse consequences to the capability of the Nation to secure critical and strategic materials, and which affect the health of our domestic minerals industry.

Perhaps one way to visualize the U.S. economy is as a pyramid in which the service and commercial sectors are at the apex, the "high-tech" sector is the next layer down, and those sectors are followed in order by the light industrial and heavy industrial sectors. And, I submit, at the very bottom of the pyramid -- its foundation if you will -- are our energy and minerals extraction and processing industries, and agriculture.

As President Reagan has reminded us so often, our economic strength is vital to our ability to maintain peace and, if necessary, to defend ourselves against foreign attack upon the United States and its allies. Our capability to defend this Nation is weakened if there is peril to the foundation of the economic pyramid, which is integral to our national strength. Therefore, we must be concerned about our economic efficiency and competitiveness, and national security.

In determining how the Council would translate this general concern with the nation's strategic minerals position into a positive program, we decided first that the Council should play a leadership role, rather than a management role. The Council's responsibilities are so broad and touch many federal agencies and activities; the appropriate course seemed to be to select a few broad subject areas in which to contribute policy leadership.

The first action we took was to focus attention on the two major reports required by Congress, a Critical Materials Report and an Advanced Materials Program Plan. Our staff developed outlines for each report, and the Council met in January of this year to review and approve these outlines, which include both Purpose and Scope statements, and guidance for specific policy issues.

At the same Council meeting, we reviewed with staff several other key policy issues, including recommendations from the Mott Committee, South African sanctions, the National Defense Stockpile, and international loans.

The Council subsequently sent a letter to the Mott Committee requesting assistance on a number of issues. We asked them to establish a list of priorities for their recommendations which had earlier been referred to the Council. Their guidance will help us focus attention. We asked them, as well, to provide materials related to public awareness and minerals education for possible inclusion in the Council's Report.

The Council's Critical Materials Report is now nearing completion. Our approach will be to print up loose-leaf notebooks containing analyses of materials and issues, to distribute these to interested parties, and then invite comment, which we will incorporate.

The Council early identified seven metals to be analyzed in detail -- high-volume metals copper and aluminum, alloying metals cobalt, chromium, and ferro-silicon, and the defense-oriented metals titanium and germanium. At the Council's request, the Bureau of Mines has prepared reports which analyze trends in demand, including conservation and substitution, and in domestic production, including developments that might present security concerns. For example, the movement offshore of aluminum smelting, and the deep troubles of titanium sponge producers, are cause for concern. We need to better understand the economics of these industries, both domestic and international.

The Critical Materials Report will look particularly closely at cross-cutting issues that affect minerals availability generally, such as environmental regulations and access to federal lands for minerals exploration and development.

One cross-cutting issue of great concern to me is that, as a nation, we are becoming increasingly reliant on offshore minerals supplies. A few examples are in order. We import 99 percent of our manganese, which is indispensable to steel production. We import approximately 82 percent of our chromium, used in the manufacture of stainless steel and in superalloys for applications ranging from automobiles to jet engines. We import about 95 percent of our cobalt, used in superalloys for gas turbine engines, magnetic materials and electrical systems. And we import approximately 95 percent of our platinum, used in automobile catalytic converters and as a catalyst in the petroleum and chemical industries. We need to understand why the United States may not be competitive in these areas.

A worrisome aspect of this level of reliance on imported minerals is those few cases where our sources of supply are countries which, by reason by political differences with the United States, internal strife or otherwise, cannot be regarded

as assured sources. Although in some instances alternative sources may be found to replace disrupted supplies, it is not prudent to fail to recognize that some alternative sources may be better and more secure than others.

We must be concerned with maintaining reliable supply sources for critical materials, wherever these may be. One obvious area of concern is the rich mineral resources of southern Africa, and the Council is working to help insure that implementation of the 1986 Anti-Apartheid Act protects U.S. access to vital South African minerals. The Council participates in the inter-agency group, headed by State Department, that is implementing those sections of the Act - 303a, 504a, and 504b - relating to strategic minerals. The Administration's already-submitted reports to Congress on 303a and 504a satisfactorily protect U.S. minerals interests, and we will be working on Section 504b, which requires the U.S. to develop a plan to diminish U.S. reliance on South African strategic minerals.

Advances in materials are adding new commodities to the list of critical and strategic materials. For example, germanium has important new uses in infrared guidance systems and fiber optics. We see an ever-increasing need for gallium in microwave equipment, solar cells, lasers and integrated circuit chips. Fiber optics are increasingly vital to communications, advanced composites to aircraft construction, and advanced ceramics to a variety of situations requiring high resistance to heat. In order to get a clearer overview of federal research programs in such advanced materials, the Council will prepare an advanced materials R&D program plan in conjunction with OMB, OSTP and the major materials R&D agencies -- the Department of Defense, NASA, NSF, and NBS -- as well, of course, as the Departments of the Interior and Energy.

In addition to the Critical Materials Report and Advanced Materials Program Plan, the Council is looking at a variety of policy issues. Of importance to both advanced materials and basic minerals is technology transfer -- the effort to translate American's programs of scientific research into commercial advantage to the U.S.

To better understand the tech transfer process in materials science, the Council staff has met with researchers in industry and academia, including visits to the M.I.T. Materials Processing Center, Rutgers Ceramics Center, and the University of Delaware's Composites Manufacturing Center (overseen by Dr. Byron Pipes, who is testifying this afternoon).

The staff has discussed with DOE staff a plan to hold hearings in federal labs around the country, at which both federal and industry materials research managers would discuss how research findings can be more swiftly transformed into commercial usefulness. Furthermore, the President's recently announced Competitiveness Initiative includes several proposals

to speed technology transfer, and the Council will monitor how implementation of these affects materials science and engineering. In addition, the National Academy of Sciences has asked the Council to review, at an appropriate stage, its current Materials Science and Engineering Study.

The Council is deeply concerned that certain environmental regulations may be so burdensome as to force closure of vital mines, mills, and smelters. The Council also is concerned that excessive restrictions on exploration and development of critical minerals on federal lands is endangering the nation's mineral security. The Bureau of Mines is studying the severity of restrictions on federal lands with the greatest potential mineral values, and we hope from this study to learn where we could focus our efforts to relax unduly severe controls. The Council will continue to receive input from the Bureau on current emerging regulatory issues which could have significant impact on the domestic minerals industry.

The Council has concerns about International Financial Institution loans to Third World mineral producers -- both direct project loans, and IMF Compensatory Financing Facility loans, which encourage overproduction in depressed markets. At Council direction, the Bureau of Mines is studying these loans to establish the amount of subsidies involved, and we will use this study in discussions with other federal agencies dealing with IFI loans.

To conclude my testimony, I would like to repeat that the Council's central theme is the health and competitiveness of the domestic minerals and materials industries and the importance of these industries to the national security. In pursuit of this objective, we are considering many avenues which will lead to improvements in our understanding of mineral and materials issues.

I welcome your questions.

Mr. McCURDY. Mr. Secretary, you had stated to me earlier, and I think it's clear in your statement, that—that you recognize there's—there's been unnecessary delays, and that you indicate you are not satisfied with the timetable, or at least the production so far.

Can you be a little more specific as to why this report is not forthcoming? Has it been from a failure to have the materials—not the information available—that it is a question of your staffing as far as people who have the expertise to understand the depth of the problem?

I mean, there's a—I mean there are reports—there have been a number of reports throughout the government on the nature of some of the problems in critical materials. The Armed Services Committee has had a series of reports dating back into the '70s on this, also in industrial preparedness and the problems there.

Can you be more specific as why this has been so time-consuming?

Secretary HODEL. Well, I think probably I have to bear a fair amount of the responsibility. Coming on four months ago, one of the things that your predecessor I think expressed concern about was that a new chairman coming on and a new Council member coming on would first have to take stock as to where are we. And that, of course, always happens. Now, we tried to compress that period.

I think I failed to make sufficiently clear, and the Council and I when we acted in January, to make sufficiently clear what our requirements were with regard to target dates and, therefore, we did not—we did not set up in the very first instance as managers the standard by which the staff was to perform.

Secondly, I did not establish a mechanism for pursuing the schedule to see to it that the intermediate dates were set. I—if I could comment, I'm a firm believer in a management by objectives process. If you want something to come out the pipeline in three months or six months, you'd better not only fix that target date but you had better go back in between and fix intermediate target dates by which drafts must be done and the like.

We did not do that, and as a result, I think we may not have made clear enough what we needed or what we wanted, and I think, therefore, we have to bear the responsibility for that.

Mr. McCURDY. Is the Council adequately staffed?

Secretary HODEL. I believe that the Council is—is adequately staffed in the—in this sense of the word: it has—it has the ability to draw upon enormous talent and resources in—right off the top because of Mr. Martin's and my participation—enormous resources. In fact, a great deal of work is going on at this time in the Bureau of Mines producing materials that will be a part of these reports.

We couldn't hire that talent. We—we couldn't have hired that talent from the time we came on board until now if we had done nothing but interview and hire people. It's there, it's available. What it needs—what the Council needs to establish are the patterns of interaction so that—so that the Council staff and the Council know who to tap and how to tap it in the various bureaus to get the material when it's needed.

Experience is a step, but we have to drive that process. And I think this is where the—Assistant Secretary Ziglar's participation will be particularly useful.

Mr. McCURDY. Who will actually prepare the report?

Secretary HODEL. The actual—the actual preparation of the report will be a composite effort, and the editor will be, as presently planned, consultant Perry Pendley, who was a Deputy Assistant Secretary and is very knowledgeable in this area. He will actually, as I understand it, do a large share of the overview drafting, compiling in that draft materials provided by the various departments and agencies that are participating. But to see to it that we have the consistency that a single editor provides for such a document.

Mr. McCURDY. Will he be the same for the Advanced Materials Program Plan?

Secretary HODEL. I do not know.

Mr. McCURDY. Staff indicates that Mr. Pendley is a lawyer and one of your predecessor's appointments—appointments. Being a lawyer myself, I am not sure that's too critical but it—and, hopefully, they would understand how to write a report. Sometimes it takes that person to sit down at the typewriter and start as opposed to keep searching for more and more information.

I have written enough and have directed enough of them myself to know that sometimes you have to commence, and I think it's important that you set those dates—those intermediate dates—and demand that they be met. And if not, then I'm afraid you'll have some micromanagement from here that we don't care to get into ourselves. But they'd be forced to—to become involved, and that is not our role. We don't want to play that but it's clear that we need to move this along on both the Report and the Program Plan. We see both as being essential and that it's important that we move forward.

Tell me about the Council—and we have a few more minutes before I go vote—but what is the agenda for the activities of the Council, and how often do you expect them to meet?

Secretary HODEL. We expect to meet on demand. Obviously, any member of the Council can suggest a meeting as required, as he feels appropriate. The—the agenda is--is driven by the decisions made in the January—in the January meeting of the Council.

The next—the next major items confronting the Council will be the review of the Critical Materials Report and presumably an outline for the Advanced Materials R&D Program Plan.

We have also a number of things that we have participated in. We participated in the response of the administration in the Anti-Apartheid Act to the Congress. We have asked the Mott Committee to provide us with a list of priorities among the recommendations which they have made. When we receive material from them and other materials, critical materials draft, we will have to have a session again, at which we react to the reports that have occurred—the material that's come in.

Mr. McCURDY. We had Admiral Mott before this subcommittee a couple of weeks ago and he was an extremely articulate and forceful witness. And certainly there was no lack of information there, and they had a clear agenda, it appears, and were not experiencing—I didn't experience any lack of energy level there. And he cer-

tainly carries a lot of experience in that young frame and I'd like to—to recommend that you utilize his—his group's expertise. And we had hoped that—I encouraged him—as I understand, he's already written some letters to you and others trying to—to move along. And I'd certainly encourage his participation in—in your use of that expertise.

Secretary HODEL. Mr. Chairman, may I comment on that? I—I agree with your recommendation and we have met not only with Admiral Mott but with a group of individuals—knowledgeable, experienced, many of them we identified as people having views about how the Council ought to function, what we ought to do. Clearly, much of our agenda is a result of the Mott Committee work, and the continued persistence of Admiral Mott to see to it that these matters not fall through the crack—for which I commend him and encourage him to continue that effort so that we don't find ourselves not responding.

Mr. MCCURDY. The—as far as the Federal materials policy activities, what formal interactions have taken place between the Council and the Office of Strategic Resources in Commerce, and the Committee on Materials or NSC? Can you give us any——

Mr. HODEL. Mr. Chairman?

Mr. MCCURDY. Why don't you identify yourself for the record?

Secretary HODEL. If I may ask Mr. Brien Benson, who is the Staff Director for the Council, perhaps he should give you the answer to that question.

Mr. BENSON. Thank you.

In regard to Mr. Robert Wilson, the—okay, thank you—the Department of Commerce—we've been in touch with Mr. Wilson. We particularly reference to COMAT. Greg Henderson is the new Chairman of COMAT. Mr. Henderson came out of the private sector very recently. He's a very able, very energetic person, and I'm very—I'm very—looking forward very much to working with him.

We are—we particularly discussed with—with COMAT a monitoring of the President's competitiveness initiative provisions as they relate to materials science, and we have had discussions—discussions with him about how we might set up a mechanism for monitoring the implementation of those.

Mr. MCCURDY. Is there a formal mechanism, though?

Mr. BENSON. No, as I say, right now, I've been just talking with Mr. Henderson. We haven't set up the formal mechanism, no.

Mr. MCCURDY. Okay.

Do you think it's necessary to have a formal—would it be helpful to have a—to set this and establish a mechanism for this exchange and interaction?

Mr. BENSON. Oh, I'm not—I guess formal means different things to different people. I guess all I—all I meant by a formal mechanism was a—a method of drawing up a list of—of priortized elements within the initiative that we would want to track, and some kind of just a mechanism for tracking them and reporting to the Council with—with observations as—our observations on the progress—would just simply be an internal kind of mechanism.

Mr. MCCURDY. Has the Council had briefings or been briefed on the Advanced Materials Programs in DOD, NASA, or DOE?

Mr. BENSON. Well, we have—I wouldn't say that we've set up individual briefings on—on specific programs at any—for a given agency per se. I've certainly tried to keep in—in one way or another, I've tried to keep the Council apprised of—of general themes that—that we have pulled out from our—from our staff level meetings.

Mr. MCCURDY. Have you made any use of the studies by COMAT, OSR, or others? And if so, which ones?

Mr. BENSON. Well, I—I—I would say in response to that, that we—I tried—I guess as—as—as one develops a sense of—of what issues to look at, this comes from a variety of different sources. Just—just to take an example, I thought the—the OTA study, which was overseen by Greg Eyring, I thought was an excellent study. I thought as a—gave a very—was a very impressive effort at putting together a realistic appraisal of—of the markets for—for composites and advanced ceramics. That would be—an example of a study that I thought was—that I thought was particularly useful, it took a broad—it took a broad view more of a—a broad policy view that would have the cross-cutting approach that—that the legislation suggests that the Council should be pursuing.

Mr. MCCURDY. I—I—I pick up a—some broad generalities, and I pick up some—maybe some—some themes, and I'm not even sure of those. Can you give us more specifics exactly how the Council operates on a day-to-day basis? I mean, are you—do you have—how many staff people do you have?

Mr. BENSON. On the Council payroll, there is myself and an administrative assistant. We have a very small budget. The Council's total budget is $175,000.

Mr. MCCURDY. Is budgeting an issue? I mean, is it restricting your activities?

Mr. BENSON. No, no, no. I'm just—you asked—when you asked what—what was our staffing and—and Secretary Hodel had—had addressed the issue of staff availability in agencies—but I am attempting to be responsive to your immediate question as to our own particular staff.

Mr. MCCURDY. Well, I'm—I'm concerned that—well, obviously, the report's not been done yet, and we don't even have an outline. And yet, I—you're not able to—to—to demonstrate even any formal interaction between these relevant committees and councils, and not even be a little—at this point, provide a—any specifics on what studies you're relying on. So I'm questioning you about your structure.

Mr. BENSON. Well, Mr.——

Mr. MCCURDY. The legislation authorized up to—to $500,000 for staffing, and the issue is: Do you need more people? Do you need more money? What is the delay? Do you need direction?

Mr. BENSON. If I could back up for a moment to your—the question of—of the studies that we—the studies that we've relied on, the studies that we have, the people that I've interacted with. I would be delighted to submit for the record a list of our specific—the specific context at the various Federal agencies. I—I estimate probably there are a couple of dozen people at something like six to eight agencies around that we rely on that I pick up the phone to say what's going on—you know, bring me up to date on X, or what

happened on Y? And I would be delighted to submit that for the record.

Similarly in regard to—in regard to the studies that we have reviewed, you know, my office is—is stacked full of these. And I would be absolutely delighted to submit for the record a list of studies, so——

Mr. McCURDY. Well, I'm—I'm more interested in the coordination of the activities than I am the actual—the numbers. I want—I want to——

Mr. BENSON. Right.

Mr. McCURDY. I'm trying to pin down exactly what—what is being done there.

We're going to take a—about a five-minute recess for this vote on the Highway Bill and I'll be right back.

[Recess]

Mr. McCURDY. Mr. Secretary, I apologize for the—the delay there, but we had to—to vote on the Highway veto. And I think that's it for a while, so perhaps we can complete here.

From the AUDIENCE. Can you tell us what happened, Mr. McCurdy?

Mr. McCURDY. Oh, yes—I remember the—the vote was 320 or 30 to about 70. So the—the veto was overridden, which was probably not unpredicted by those that were watching that one in the House. The issue will be on the Senate side, of course. I don't know how close that will be. But maybe—anyway, we will go on to the next issue here.

As the author of the 65-mile-an-hour speed limit amendment, I can tell you where I stood, but [laughter] anyway, we were following the issue on the materials policy and the overall coordination of these activities and Mr. Benson was—was trying to—to respond and outline the—the overall coordination of these efforts. And I would—now that you've had a few minutes to—to anticipate the questions, maybe you have some further statement. If not, we'll——

Mr. BENSON. Well, I might—and I—I hope I'm being responsive to your—to your line of questioning, to take for example the critical—the Critical Materials Report, the selection of the seven minerals was—was my recommendation to the Council to pursue those. And that was based on my meetings with—my meetings with a variety of people who—who were looking at—were looking at these issues, and so that was being presented to the Council.

Another example of—of providing—providing the coordination function, the Secretary's testimony made reference to the tech transfer issue. And based on my talking with—with a variety of—a wide variety of sources and people involved in—in the Advanced Materials area, what sorted out in my thinking was that the tech transfer issue seemed—seemed to be one that was particularly suited for the the Council with its overall vision—overall cross-cutting responsibilities and—and at the same time then I worked with Ted Harris, who is Mr. Martin's liaison with the Council. And this seemed to him a—we agreed that this seemed to be a reasonable approach—project that should indeed be—be a priority project. And based—based on that—and this was presented to—to the chairman as a—as an initiative.

So those would be two examples. Is this—am I being responsive to your concern?

Mr. McCURDY. Well, I—Mr. Benson, perhaps I need to find a little bit more about it—exactly what your responsibilities are and duties as the Director of the—I understand that Mr. Pendley will be coordinating the actual draft or editing the draft, and you are the Staff Director; is that correct, or——

Mr. BENSON. Right.

Mr. McCURDY. So there is a clear delineation there—I mean, you're not in charge of the report, or are you?

Mr. BENSON. I prepared an Outline of the Critical Materials Report that the Council approved; I directed the Bureau of Mines' preparation of the seven minerals studies in the Report; and I collected some 400 pages of additional material on various minerals issues, such as reliability of sources of supply and national requirements for minerals education. Perry Pendley is now editing this material and writing an introduction. Well, Perry—Perry is—is the, if you will, the editor, the overall editor, of the report. I spent 10 years in—in the publishing business and I was—I was head of a little publishing house and we had an editor-in-chief, and that was a very clear relationship and worked—it worked out fine. I—that would be the—certainly I see no problem there. Perry and I work very closely together. We have a good working relationship. Perry has a—Perry has a strong background in—particularly in some of the cross-cutting issues. He is—he's an exceptionally good writer. Perhaps that's some of his legal training coming through.

Mr. McCURDY. What are your responsibilities as outlined in the statute, Mr. Benson?

Mr. BENSON. Well, I could read—read them off. I——

Mr. McCURDY. No, I was asking if you—if you knew them off the top of your head.

Mr. BENSON. Well, sir, I mean my perception of an executive director as—as the job is evolved is, number one, to—to be maintaining liaison with a variety of agencies in the Federal Government that are dealing with both advanced materials and some minerals issues; to pull together a general sense with—with a vision in mind of the Council and the Council's overarching responsibilities; to pull these—pull together some of these themes, strains; bring them to the attention of the Council, and then to—to the degree that the Council gives direction to move in this, that, or the other area, to do my best to implement that—to implement those.

And I've given you a couple of—two specific examples where that—in the case of critical materials and in the case of this moving ahead in the area of the tech transfer program that we've been discussing. Those would be two specific examples of how that process worked. Furthermore, I prepared, and the Council approved, an in-depth outline for our Advanced Materials Report. In addition, I have presented to the Council briefings on such other issues as South African sanctions, South Africa's strategic position, National Defense Stockpile finances, the National Defense Stockpile Manager, and the effect of International Financial Institution mineral loans on the domestic mining industry.

Mr. MCCURDY. Have you initiated any government or private studies to—either by the Council or the Department designed to advance your knowledge of the critical materials issue?

Mr. BENSON. Well, the private—the private studies problem is—is simply a budgetary question. I mean, there's simply no—no getting around—no getting around the fact that if you don't have money to do contracting, there's not much—there's not much opportunity to move ahead there.

As I say, within the government, again, to point to those two examples, those are the—those are the two obvious examples. In the case of the critical materials study, the studies are being performed in significant measure by personnel in the Bureau of the Mines, and I'm working with them. And in the case of the tech transfer study, this will be—we'll be working—the lead there would be with DOE staff. I've also worked with—talked with Greg Henderson in COMAT in terms of getting guidance there. But again, there—that would be an example of another government agency, which we would expect would be—would be assuming the—the burden of carrying out the program.

Mr. MCCURDY. So what you're telling me is you delegated to certain agencies functions, either responsibility for drafting portions of the report, or at least providing you information as it pertains to the report; is that correct?

Mr. BENSON. I—yeah, I guess you could call it delegation. Right, it's correct.

Mr. MCCURDY. Do you have a—a calendar by which you—you require certain reports to be to you? When—when is your draft going to be available to the Secretary, Mr. Benson?

Mr. BENSON. Well, in the case of the Critical Materials Report, we're certainly hoping that we should be able to present the Council within four to six weeks for their consideration. So to that extent, yes, we do—we do have a calendar there.

Mr. MCCURDY. I mean, do you have a rough draft now?

Mr. BENSON. Yes, we do. That's correct. In fact, it's sitting under my chair.

Mr. MCCURDY. I hope it's elevating. [Laughter.]

I would hope that—that you would sense from this Chair and that members of the committee that we're concerned that this report has not been forthcoming and that there's been delay. And I am somewhat concerned about the—the organization from which its supposed to—to emanate. And I am—can you tell us, Mr. Benson, just quickly—and I will let you off your report here in a minute—where—what is your general views on the critical materials?

I mean, a staff director is supposed to be a person that—that supplies information to the—the committee or the chairman, or whomever, and to coordinate this, and compile the information, and to really kind of provide the framework for a lot of these activities.

And we—I, certainly on other committees I don't always agree with the staff director, and we sometimes have long discussions of philosophy. But what I'm trying to find out from you is exactly how do you see the critical materials issue? I mean, is this a private sector concern? Is this a government policy issue? Is this a crisis? Are we in a crisis? Is this something that's manageable?

What is the role of the government and what is the role of the private sector?

Do you have any general concerns in that area?

Mr. BENSON. Well, Mr. Chairman, if I may say so, the—the three members of the Council are—are the—are the policy-making officials to whom I report. And they are all—they are all PAS's. I'm not a PAS. And so, really, if I may say so, I think that—that they are—they are the appropriate spokesmen for the policy positions, the policy perspective of—of the Council.

Mr. MCCURDY. Have those three given you policy direction on this issue?

Mr. BENSON. The—the Secretary earlier this afternoon has expressed his very—very clear concerns in the—in the general areas of both fuel and non-fuel mineral dependency—that clearly comes through in the testimony. And I don't think—I don't think I've ever heard anybody suggest that Secretary Hodel is—is afraid to express his positions on policy issues.

Mr. MCCURDY. I wasn't asking the Secretary about his——

Mr. BENSON. Well, you asked—you asked if he had made—you asked if he had made clear to me his policy orientation.

Yes, Mr. Chairman, he certainly has.

Mr. MCCURDY. So you have a blueprint that you're following? You have clear directions as far as you're concerned?

Mr. BENSON. We have—there's a very—there's a very clear policy framework, and the Secretary has expressed—expressed in his testimony, I think quite clearly, what—what that policy orientation is.

And in fact, there are two specific examples cited in the testimony—the concern with the movement offshore of aluminum smelting and the—the serious financial problems of domestic titanium sponge producers, which are specifically referred to, and which I think reflect two very specific examples of—of the chairman's concern.

And I would certainly think that the—I would certainly think that this is exactly the kind—it is exactly the kind of issues that the critical materials inventory is meant to—to be flushing out, at least that's certainly my perspective.

Mr. MCCURDY. Well, the flushing has been awfully slow.

The—on a—one last question for you, Mr. Benson, and that is: Is there a problem, from your standpoint, of acquiring information regarding the critical materials issue? Do you have—have you had any difficulty acquiring information because of classification, because of political borders, or politics, or any particular reason that you've not had access to the information from which you could base the report?

Mr. BENSON. You're talking about access with—within the Federal Government, do I understand correctly?

Mr. MCCURDY. Anywhere, Mr. Benson. I mean, if—if you have problems acquiring information or having access to information, I would like to know. Perhaps we can assist you in getting some of this information. If not, then I don't understand exactly why again it's been so difficult for you to come forward with a report.

Mr. BENSON. Well, I wouldn't—I wouldn't say—if you're talking about the database questions, no, I'd—no, no, sir, I wouldn't say

that we—there's any problem in getting access to specific data. I've never approached any organization and, you know, said, we'd like your assistance with this, that, or the other thing, no.

Mr. McCURDY. So it's not an information problem. So it's an analysis problem. Do you have a problem analyzing any of the material or information from whence this report could come?

Mr. BENSON. Well, I would—you know, as—as—as the Secretary—as the Secretary indicated, you know, he's not happy with the progress, the Critical Materials Report. And I'm certainly not going to sit here and say that I think the rate that—that we've been moving at I'm delighted with. Obviously, I'm not. I—I would—I would like to repeat the point that the Secretary made. I think that having Assistant Secretary Ziglar as the Secretary's liaison is—is going to be a very, very significant contribution to the—to the progress on these reports. And I am personally am delighted at the assignment.

Mr. McCURDY. Mr. Ziglar?

Mr. BENSON. Mr. Ziglar's assignment. I am delighted that he——

Mr. McCURDY. Well, I'm sure the gentleman from Mississippi is going to be a tremendous asset. I think he has his work cut out for him and certainly there's some obvious challenges that I've observed, and I think others probably would have to agree.

Thank you, Mr. Benson. I have some other questions but I am going to defer first to my friend and colleague from Florida Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman.

Mr. Secretary, good afternoon. I'm sorry we're running in and out but it's one of those days.

[The prepared opening statement of Mr. Lewis follows:]

OPENING STATEMENT

HON. TOM LEWIS (R-FL)

TAM HEARING ON THE CRITICAL MATERIALS COUNCIL

MARCH 31, 1987

THANK YOU, MR. CHAIRMAN.

THE NATIONAL CRITICAL MATERIALS COUNCIL WAS CREATED DUE TO THE EFFORTS OF THIS SUBCOMMITTEE TO FILL AN IMPORTANT VOID IN THE FEDERAL GOVERNMENT. THAT VOID WAS THE LACK OF COORDINATION OF CRITICAL MATERIALS RESEARCH AND A LACK OF A RESEARCH POLICY, AMONG THE VARIOUS FEDERAL AGENCIES.

THE APPOINTMENT OF MR. HODEL, SECRETARY OF THE DEPARTMENT OF INTERIOR, AS THE COUNCIL CHAIRMAN SIGNALED THE ADMINISTRATION'S SUPPORT FOR THE NATIONAL CRITICAL MATERIALS COUNCIL.

SINCE ITS CREATION, THE PROGRESS ACHIEVED BY THE COUNCIL HAS BEEN DISAPPOINTING. BUT I AM OPTIMISTIC THAT UNDER MR. HODEL'S STRONG LEADERSHIP THE COUNCIL WILL PROVIDE THE NATION WITH A COMPREHENSIVE, COORDINATED MATERIALS POLICY.

MATERIALS RESEARCH AND DEVELOPMENT IS AN AREA THAT THE UNITED STATES CANNOT AFFORD TO LOSE ITS LEADERSHP ROLE. THE IMPACT OF SUCH A LOSS WOULD BE FELT IN OUR BALANCE OF TRADE AND TECHNOLOGY DEVELOPMENT FOR YEARS TO COME. CURRENTLY, WE DO NOT ENJOY A COMFORTABLE LEAD, AND IN SOME AREAS OF CRITICAL MATERIALS, MAJOR ADVANCES ARE MADE IN OTHER COUNTRIES.

THE TIME FOR ACTION IN DEVELOPING AND IMPLEMENTING A NATIONAL MATERIALS POLICY IS NOW, AND THE CRITICAL MATERIALS COUNCIL PROVIDES AN AVENUE FOR THAT NEEDED ACTION. ALL THAT REMAINS IS FOR THE COUNCIL TO PROVIDE THE LEADERSHIP ROLE.

I AM LOOKING FORWARD TO HEARING FROM TODAY'S WITNESSES ADDRESS THE FEDERAL GOVERNMENT'S POLICY IN STRUCTURAL CERAMICS, ADVANCED COMPOSITES AND RAPIDLY SOLIDIFIED ALLOYS.

THANK YOU, MR. CHAIRMAN.

Mr. LEWIS. What—what are your plans now with the Council, say, for the next 12 months? What—what are your plans?

Secretary HODEL. The—the first activity is the—get the Critical Materials Report completed, and pursue the drafting of the Advanced Materials R&D Program Plan, follow on that. We have asked for, as I indicated earlier, Admiral Mott's priorities—a list of the things which in their estimation we should be putting our priority attention on. We have—we have a number of—of areas there that we are seeking to determine how active a role we can or should play. One of the areas that's been identified to us is in the area of international finance. We have asked for some assistance in that area to determine can we pull together information that's sufficiently useful we can make a presentation of the parties involved as it affects U.S. industry. And at this point I don't know whether we will be able to do that or not, but that is one of the areas which we are pursuing.

It would seem to me that as soon as those two reports—as each report goes out, we will be, I think, begin receiving almost immediate reaction from various constituent groups about elements in those reports.

I think very soon following the issuing of the report we will be convening and reviewing suggested amendments, additions, augmentations of one kind or another to the reports. So I would expect that this first year there will actually be a fair amount of activity with the reports themselves.

My view is that they become a—a baseline over time. We will not start out with something that we can say is a baseline. It will be the beginnings of an effort to establish that baseline as we talked earlier about the Energy Security Report. And I can understand the chairman and the committee's concern about how long it's taking to get to the point of beginning to take—to start the baseline. It seems to me that we should have done this earlier. We have not—that's behind us. Now the question is how rapidly can we do that. So I think this first year will be very much a baseline establishing time.

If we are successful in producing something truly useful, I think—I think that the document then will establish the extent to which there is a problem which can be agreed upon so you can begin to talk to a broader audience about what solutions ought to be pursued.

I would think that will then begin something the National Critical Materials Council will begin to become participant in—the discussions of solutions, or proposals.

Mr. LEWIS. That would mean by March 31, 1988, we'll have the reports. [Laughter.]

I didn't mean to do that to you.

Let me ask you a question you may or may not be asked, but I think maybe the Critical Materials Council may want to investigate. We are looking throughout the country with high speed trained technology. And one of the greatest expenses we've experienced with this is when we're looking at magnetic levitation and certain other areas we want to come up with a combination of metals so we can have superconductors and in order to do this you've got to get the temperatures down to an extent that—and we

have had to cool them with helium, certain ones, so that you are about absolute—close to absolute zero as possible and all that.

They've come up with a new method in recent weeks using liquid nitrogen which certainly puts a lot of this in the ball park now and out of the tremendous expense coming up with helium. And in order to do this you have to match the different metals, critical metals, in order to—to accomplish the same thing that you would do with helium.

How do you think that with—when we're getting into technology like this that the Critical Materials Council or whatever support would be necessary would like to keep the Japanese from stealing this from us, or anybody else?

Secretary HODEL. I—I don't have any—any idea how one goes about preventing the transfer of technology. I say it that way because—

Mr. LEWIS. I have no problem with honest transfer.

Secretary HODEL. I realize.

History—commercial history—as far as I can tell, is full of industries and governments attempting to protect their technology from being—from being stolen or acquired by competition. And it is, to my knowledge, never been successful.

The—what is fascinating to me in this cryogenic technology we're talking about—superconducting technology, which is not so heavily cryogenic-dependent, which we're now talking about—is that if I understand the press reports that I've seen this was very nearly a simultaneous development going on in at least three different countries at the same time.

That is also not uncommon in science where, as we look back through science, we find that Smith gets credit for the invention and Jones claims that he was the fellow who actually did it first, but there was no connection between the two. Somehow, the scientific genes exploded at exactly the right—at simultaneous times.

My—my belief is that the success of the United States in the technology area where it is successful—and it is very successful in some areas, many areas—in fact, broadly, more than any other single country—the success is because of the enormous vitality that comes to this country because of the vast array of areas that are pursuing, many times independently, these various avenues.

It seems to me that—that the Council—I don't see the Critical Materials Council, as I currently understand it, to be an avenue for somehow putting a barrier around information. I can see where it may very well be a clearinghouse for information, which would help national laboratories at the Department of Energy, major high tech industries to know what's going on elsewhere within our own industries. And through that cross fertilization, perhaps accelerate their successes.

When I was head of the Bonneville Power Administration, I served on the Board of the Electric Power Research Institute, which was both a fascinating and very educational experience.

We were talking about high voltage transmission—cryogenic transmission—because it held great promise for not only large volumes of electricity being transported, but also it increased the possibility we might be able to go underground, which was rapidly at that time becoming a serious problem. Current technologies being

infeasible for lengthy underground activities and politics being such, it was impossible to go overhead. And today this country, in my estimation, needs additional transmission capacity, and it isn't building it because it's politically infeasible.

These cryogenic technologies which—or these high—these superconducting technologies—I date myself every time I say cryogenic because it—it's——

Mr. LEWIS. No, I understand what you're saying.

Secretary HODEL. When I was involved, you had to get close to absolute zero in order to have superconducting properties.

The—it appears to me these are very promising, and very helpful, and we'll have a wide range of applications. But it doesn't look to me as if the National Critical Materials Council will control that technology. I think where we would come in is identifying if they are, and what they are, if they are, critical materials in that technology.

And if there's an Advanced R&D component there where the government is involved, what its relationship should be, not only within the government but to the external activities.

Now, that's a heck of a mouthful.

Mr. LEWIS. Yes, it is.

Secretary HODEL. That—to accomplish that at this moment, we are not equipped to do. And until we get these baseline reports, I don't see—I don't see that we can fulfill that function.

Mr. LEWIS. Okay. Thank you, Mr. Secretary.

Thank you, Mr. Chairman.

Mr. MCCURDY. Thank you, Mr. Lewis.

Mr. Secretary, only a couple more points, and that is on the—the Program Plan as opposed to the Council Report, and that is, as I understand it, that program plans should establish at a minimum on the goals and priorities for research and development.

Secondly, you should have some bench marks—which we've alluded to—and funding levels over the next five years. We should have—that should be in the plan. We should have some anticipation of what those funding levels should be, and then we should have some identification of the lead agencies involved.

Now, as—do you see any problem in having those developed before 1989?

Secretary HODEL. I—I see—I see a problem, a generic problem, in—in that effort. I think—I think the—acquiring the information about what's going on in a broad sense will be relatively easy, and that we're in the process of acquiring it—probably already have some of that. That will be relatively easy because each of the departments already has budgets in which they make that kind of disclosure and there's no problem.

You go to the next level, the actual—when you start getting into the specifics of the application, my experience at DOE would suggest to me that even within the Department there is a certain amount of competition. In fact, some of it was intentional at the Department of Energy.

We had national laboratories doing research on the same issues in order to keep from making what I think is the typical governmental mistake, which is for budgetary reasons usually—but not always, sometimes for the reason of the psyche of the director of a

program, you decide on the winning course and you put all your horses on that and it turns out you were on the wrong horse. At the national laboratory we've actually had competing approaches.

The—when you then get down—try to get down to the—into more of the details, you don't always get a straight response from the competing organizations. That may be harder to get specifics on some of the advanced or critical materials that some people are working on.

I think that when we have that information it will be relatively easy to identify the broader goals and just as hard, then, to speak on the specific goals that may relate to a particular activity—for instance again, DOE.

Funding, I think initially, will be basically—I think our initial cut will have—will automatically turn out to be a parroting of what is provided us by those departments. Only after we've been through at least one iteration of this process, and we say all right, here are the cross-cuts, here are the—here are where NASA and DOE, and DOD, are all engaging in something comparable—that we—that we can start talking about suggesting—and I don't know what the right word is—coordinating, alterations in that activity.

If it looks like NCMC is going to try to do that, or the Office of Management and Budget is going to try to do that, or this committee, or the Congress is going to do that, each agency will be very defense if it feels that its activity is essential to its agency mission.

Somehow we have to—we have to be sure we don't appear to be a threat to those supplying us with information or, frankly, the information will not be very good—not be very current. In fact, we won't get a handle on doing what I think this committee, the Congress, and what I believe we are charged with trying to do. My sense is, we are intended to try to rationalize—really rapidly rationalize—the process by which expenditures are being made, goals are being set in Advanced R&D.

That's commendable, and it's desirable, I think we would all agree—it will be difficult to do.

Mr. McCurdy. Well, I—I'm not sure I disagree with you, Mr. Secretary. I—this—I don't see this as a partisan issue. I don't see this as a parochial issue. This is not some esoteric issue only of interest to ex-Admirals. I mean, that's not the case. This is a national issue. It's a national priority. And what we are suggesting to you, and that the idea behind the Program Plan, and behind—the idea behind the Council, is to—to—to effectuate and implement the—the coordination of policy; not to sit here and say, look, we expect you to just put, you know, put all your money into ceramics, or in composites, or advanced, you know, superconducting materials. That's not the issue.

The issue is to have an inventory of all the government process, all the different agencies, to insure that work is being done in those. And if there are areas that we are not doing enough, then perhaps we could light the fire under that particular agency. And we don't want to make—we want to make sure that Ron Kerber doesn't have all the R&D monies in the world, that DOD doesn't have it all. He'd like to have them all, but he cannot have them all. That NASA's involved, and NSF, the private sector, that we have a—a coordinated effort.

And I—every hearing I've been going to lately I have to show these. I mean, you know, look in this one area—the Japanese sure aren't afraid to do it. This is a remote sensing document—we're having a hearing earlier today on LANDSAT. We've got media involved to—which is not unusual, but look who they have with them. They've got the Metal Mining Agency of Japan, Earth Resources Satellite Center, Japan National Oil Corporation, Japan Petroleum Exploration Company, Japex Jewel Science Institute. And then they go in the other column, they have Toshiba, Hatachi, Fujitsu, Mitsubishi, Remote Sensing Center. You know, I mean, they don't have any problem coordinating. I mean, it's—it's—there's no philosophical problem there. They don't have any antitrust problems, which I understand is a different issue, and, or it's an issue that's involved here too.

But all we're asking you is to elevate this issue to the point—and what we try to do with the Council is to—to put a top on that pyramid and say, look, someone has to know what's going on in the Federal Government.

And—and why in the world do we get in the situation where all of a sudden we're--we could be dependent on foreign sources, not for materials, but for chips, and other issues. And we—we need a better analysis within the government. And we had hoped that this Council could provide some of that—that effort. And it shouldn't be—do you have philosophical differences with that approach?

Secretary HODEL. I don't think I do. But I could extrapolate, Mr. Chairman, from what you've said to a point where, yes, I would. But I'm not sure that you were—you were going that far, and I don't—and I don't—you know, it's not my style to look for points of difference with chairmen of key committees.

But I—I think that—that the role of this Council in trying to provide leadership in this area is one that the Council is comfortable with. Where I think—where I think nervousness exists, and will exist, is anytime it might appear that the Council would want to drift from leadership—which is coordination and advocacy, and communcation, and tech transfer, all those good things—into management, or direction, or scoping, or, heaven forbid, budgeting. And I think that if I were still——

Mr. MCCURDY. But without the leadership, then what you have is a vacuum, and then you have the Congress trying that—and Congress is not suited for it. Congress should not be doing the micromanaging, whether it's in the Department of Defense or Intelligence, or Interior, or whatever. And when you see a lack of leadership, or a vacuum, and there's no one addressing a—a crying national need, then everyone rushes at the same time.

What we're asking you to be is a point man, and we're asking the Council to play point. And we expect them to be identifying those issues early on, with the given resources in the government, to tap those resources and have that communication flowing to you.

You cannot do it, though, if you have two staff people that are not exactly sure where they're going, and what their direction is, and they don't have—you know, you've got to light the fire on those reports under those staff people to get it done.

And if you don't do it, then you're going to have a far worse situation than we have today. And that's all I'm asking. I—I think philosophically, you as a——

Secretary HODEL. With that I do agree.

Mr. MCCURDY [continuing]. Key Republican and me as a Democrat can agree on that.

Secretary HODEL. I agree.

Mr. MCCURDY. That is an American issue that we should be concerned about.

Secretary HODEL. Absolutely. And—and I think that—I think that—maybe I should say—I have not said this—that the reason—the reason I acquiesced an appointment to this position was my concern for the area, which I think is extremely important to the long-term health and stability of our economy and our national security.

And my—my concern at the time, which has been confirmed in subsequent times, was that my concern was that it would not be amenable to solving the problem. And I'm not encouraged so far that there are solutions out there that jump out at us.

So at this point, I'm looking at a process, to try to get to the baseline you've talked about.

Mr. MCCURDY. We can't solve the problem if we don't have the information.

Secretary HODEL. That's——

Mr. MCCURDY. And there's too much policy information out there, too much rumor, speculation, and then you get issues of trade wars, and all the other stuff——

Secretary HODEL. Right.

Mr. MCCURDY [continuing]. This hysteria out there, and xenophobia, and all the other things that get involved, and we end up with trade bills and other things that—that maybe you or I, neither one, totally agree with. But that's how it happens.

And the administration is the—is the agency—you know, this is what—this administration was elected for also—you know. It's not just a—to—to privatize everything in the Federal Government. It's to take a lead on these issues.

And there's a real opportunity here that you could make a real mark on, Mr. Secretary, if you put the resources, and the time into it. And if you need some assistance, I'm sure there's some of those that would be glad to—to loan some people to you that could make this happen.

I think you have access to—to people that can do it. I just hope that it's elevated to the point that it is done.

And I appreciate you taking the time to—to be here today. This is a small subcommittee but it does have jurisdiction over an important area, and we certainly respect and appreciate your service.

And with that compliment, I'm going to also issue another invitation. It probably be as long before you're invited to reappear before this committee, hopefully with a report in hand.

Thank you, Mr. Secretary.

Secretary HODEL. Thank you, Mr. Chairman, I certainly hope so.

Mr. MCCURDY. Good. Thank you.

Our next witnesses are Dr. Ron Kerber, Deputy Assistant Secretary of Research and Advanced Technology, Department of De-

fense. He's accompanied by Jerome Persh, Staff Specialist, Materials and Structures.

And after Dr. Kerber, we'll be having a panel of outside witnesses: Mr. James Burns, and John DeVault, and Mr. Byron Pipes.

Ron, I hope after my treatment of Mr. Benson, Mr. Persh is not afraid to come sit at the table. [Laughter.]

We welcome the—we've got a name tag up there if you want to come.

Dr. Kerber, good to see you again.

STATEMENT OF DR. RONALD L. KERBER, DEPUTY UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ADVANCED TECHNOLOGY, ACCOMPANIED BY JEROME PERSH, STAFF SPECIALIST, MATERIALS AND STRUCTURES

Dr. KERBER. Mr. Chairman, it's a pleasure to be here and appear before the committee. I am going to discuss the Department of Defense Materials and Structures Program today—a program that I'm extremely proud of, incidentally. And I have with me, Mr. Jerome Persh who is a Staff Specialist in this area, that may answer some of the questions pertinent to the area.

I have a prepared statement for the record, which I would like to submit.

Mr. MCCURDY. We'd like to have it admitted in the record and look forward to your summary.

Dr. KERBER. As you know, my responsibility includes the Science and Technology Program of the Department of Defense, and that includes basic research, exploratory development and advanced technology development part of the Department of Defense research and advanced technology program.

This program is the underpinning for the acquisition process. It gives us the technologies and the capability that allows to build the defense systems we need for the future.

These technological advantages are only temporary, and the Soviets have used their technology and their resources to build a military structure that we need to offset. To do that, we have chosen to use technology as a force multiplier, so technology is the key part of the underpinning of the strategy of the Department of Defense and the country.

The Science and Technology Program covers this by using the facilities and the skills of industry, university, and government laboratories to achieve these technical goals.

Advancement and materials are the prerequisite for advancements and other technologies. We are interested in higher strength and lighter weight materials as the essential building blocks for this superior equipment.

There are several things that materials research and development gives us. First, it's military capability for our systems.

Second, it's affordability. We spend a lot of our resources on developing processing technologies that allow materials that we have discovered to be affordable for defense systems.

And, finally, a key thing in the materials technology area is that we use materials as an element of survivability, for example, in armor, or in sensor protection, or other material protection areas.

Also, materials are key in the research to make sure that our systems are survivable in adverse environments, such as harsh weather environments and in space. We—in fact, in the fiscal 1988-89 budget have put increased resources into material survivability areas.

Today, I will discuss the structural, functional and thermal materials part of our Defense Materials and Structures Program. I will not discuss the electronic materials component of that program, which is about $64 million, and is primarily in the electronic devices area.

Our request for the research and development for fiscal year 1988 in the materials and the structural materials area is about $339 million—and that's shown on this chart.

[Chart 1:]

DOD MATERIALS AND STRUCTURES TECHNOLOGY

[In millions of dollars]

	Fiscal year—			
	1986	1987	1988	1989
Army	39	44	35	38
Navy	67	73	77	80
Air Force	72	113	129	138
Defense agencies	33	37	35	42
URI	5	10	10	[1]15
SBIR	[1]30	[1]30	[1]30	[1]30
SDI		14	23	41
Total	246	321	339	384

[1] Estimated

CHART 1

Dr. KERBER. For fiscal 1988.

And for fiscal 1989, it is $384 million, which is also shown on that chart. As you can see on the chart, the funding is broken down by the military departments and also by special programs: the University Research Initiative is URI; the SBIR is the Small Business program; and, of course, you are aware that the Strategic Defense Initiative program is SDI.

Chart 2

ESTIMATE OF TOTAL DOD MATERIALS AND STRUCTURES TECHNOLOGY IN AREAS OF COMMITTEE INTEREST

[In millions of dollars]

	Fiscal year—			
	1986	1987	1988	1989
Ceramics/ceramic composites	13	34	34	40
Advanced composites:				
Organic matrix	32	55	55	65
Metal matrix	25	40	40	51
Carbon/carbon	21	20	20	30

ESTIMATE OF TOTAL DOD MATERIALS AND STRUCTURES TECHNOLOGY IN AREAS OF COMMITTEE INTEREST—Continued

[In millions of dollars]

	Fiscal year—			
	1986	1987	1988	1989
Rapid solidification	11	13	15	20
Total	122	162	164	216

[CHART 2:]

In the next chart you'll see the particular materials areas that you indicated were an interest of this committee. For example, ceramics and ceramic composites, advanced composites—in fact, you have, I should indicate, I have given you a copy so that you can—it's not in there—it's in there but there's also a loose copy up there which would give you those tables.

Mr. MCCURDY. Okay, I found it, thanks.

Dr. KERBER. So—I'm not sure you'll find it precisely in there, but there is a—there are two loose pages up there that you'll find that we handed out with that.

Okay, if you look at that you will see that in the ceramics and ceramic composites area and in the other advanced composites area, including organic matrix, metal matrix, and carbon/carbon, plus the rapid solidification, we have for our fiscal year 1988 request about $164 million which is half of the DOD materials and structures budget.

So, with your interest and with our interest, I see a lot of compatibility because we have put half of our resources in that area. I would indicate that the remaining part of the resources go into areas like test and evaluation into other materials such as high strength steels, and in—into other areas, including structures research, which is part of the Materials and Structures Program.

Mr. MCCURDY. And then $64 million into electronics?

Dr. KERBER. Electronic materials; that's correct.

Mr. MCCURDY. Being a total of how much?

Dr. KERBER. Well, the $64 million you would add to the $338 million or $339 million.

An important aspect of the Materials and Structures Program is the coordination that we have within the Department and within other agencies. There are three processes that we use to coordinate that.

My feeling is that this is a very well coordinated program, both within the Department of Defense and within the Federal Government. I base that on the fact that I spent time at DARPA as a Program Manager in the Materials Science Division and we, at Program Manager level, had very strong coordination among all agencies as well as within DOD.

As far as the DOD coordination, we have a Tri-Service Annual Management Review in the specific technology areas. And then at my level, I have an Annual Investment Strategy Review which covers the broader aspects of the program, including materials and structures. And then, of course, at the national Federal level we

have coordination among the agencies such as NSF, DOD, DOE, et cetera.

So we have this strong coordination in the Materials and Science Program at the level where people are making the funding decisions.

This coordination also includes advisory boards such as the National Materials Advisory Board and, of course, it includes the Office of Science and Technology Policy; and we have had in discussions with my staff, Mr. Persh, with the Executive Director of NCMC who appeared here earlier.

The DOD Materials Research and Development Program has produced a number of important advances that have resulted in a large number of major applications in the DOD and in the private sector.

I am going to discuss now a few of those technologies that you expressed an interest in in your letter to us.

First, in the organic matrix composites area. This is an area that has had strong DOD participation, and essentially every military aircraft in the free world is using some material in a portion of their airframes that is an organic matrix composite.

In addition, the V-22, the Osprey, a new development, uses composites in about 60 percent of its airframe. In addition, we use the organic matrix composites in missile systems like the PEACEKEEPER and the TRIDENT, and also on smaller tactical missiles. And, of course, I'm sure you are aware that the organic matrix composite is emerging in the commercial aircraft industry also.

In 1984, there was approximately 2—22 million pounds of consumption of organic matrix composites and we expect about 200 million pounds of consumption of this material by the turn of the century.

So we view this as a very successful technology transition, both from the research to the DOD and to the private sector.

Mr. McCURDY. Could—could I ask you at that point——

Dr. KERBER. Sure.

Mr. McCURDY [continuing]. When you're going through these areas, would you highlight for the committee such issues as when—when the development—when DOD was working on this type of composite, was that a classified project? And if so, why—why were the—why was it classified? And if—at what point do you move it out? Or was there something that was going currently with industry?

Maybe you can explain it in each of these areas. Maybe—you know, perhaps most of this is unclassified, I don't know. I——

Dr. KERBER. Only 10 to 15 percent of our Materials program is classified. So if I—let me just address it that way and——

Mr. McCURDY. So very little is.

Dr. KERBER. That's right.

Mr. McCURDY. Okay, good.

Dr. KERBER. So I think I need to address it on each one then.

Mr. McCURDY. No.

Dr. KERBER. For the metal-matrix composite which you also asked about—there's certainly a need for higher strength and stiffness composites, and we developed a tri-service, including DARPA, thrust in metal-matrix composites in 1979.

And the Strategic Defense Initiative and the National Aerospace Plane Program will make extensive use of this technology. In fact, this—this technology is critical and enabling for the National Aerospace Plane, and without metal-matrix composities we wouldn't have been able to embark on that program.

Mr. McCURDY. I was at one of the contractors this weekend and they were showing me the metal-matrix and the—anyway, the cooling and all the other aspects of it.

Dr. KERBER. It's a stressing technology.

Mr. McCURDY. It's interesting.

Dr. KERBER. On the carbon/carbon composites area, the Department has a long history in the development of carbon/carbon research. In fact, when I was at Aerospace Corporation back in the early 1970s, when I was a mere child, the Department was working very strongly on the development of nose cones in—for reentry systems. And since then, we have developed things such as high speed brakes for aircraft, and rocket nozzles using carbon/carbon.

So this has been a very successful program for the Department also.

We have launched a High Performance Turbine Engine Program. That program requires the development of hot section technology, either turbine blades made of carbon/carbon that are coated so that they do not combust during the—inside the engine—or the development of a ceramics matrix composite to perform that function.

The goal of that program is to increase by a factor of 2 the thrust to weight ratio that we currently have. So I think that's a very good example of using materials and developing materials for—for a specific need.

Mr. McCURDY. Would you break that down with the ceramics and a list of the next topic—in that it—where is most of that work being done?

Is it done in government labs?

Is it contracted out?

Is it universities or where?

Dr. KERBER. Most of the work in the materials area is done in external—external to DOD. If you'd like specifics, I'll give you specific percentages for the record.

Mr. McCURDY. But most of it, you contract it out basically——

Dr. KERBER. That's correct.

Mr. McCURDY. You have contractors to just do basic research or they——

Dr. KERBER. They do basic and advanced—advanced development and exploratory development—all areas.

The majority of materials productivity and expertise lies in the—in the private sector, and we try to take advantage of that.

The last area which I will talk about is advanced structural ceramics and ceramic matrix composites. And in my opinion this is the area that we have the largest potential for the future.

The military department is—is departments and DARPA are currently moving in this area as I showed on one of those charts. And we feel that with the development of matrix structures such as the silicon and carbide fiber reinforced glass ceramics that we currently have, and by being able to engineer, if you will, materials

in the future so that we can choose the fibers and the matrix—and if we can make those so that they're not so brittle will not break, we'll have a major advantage in hot applications for structural materials. And that would, of course, go both in the turbine engine kinds of technology and in the National Aerospace Plane.

So, I personally believe that the ceramic area is the area that is likely to explode in the future for us, and we're putting research in——

Mr. McCURDY. Is this also an area that—that you would classify as only 10 to 15 percent being classified?

Dr. KERBER. That's correct.

Mr. McCURDY. Are the contractors—are they free to publish.

Explain to us, just for the record here, the proprietary rights and who owns the rights, and how is that—how that is handled.

Dr. KERBER. Well, if the government pays for the research, of course, the government owns the rights.

In some instances, and in fact, in some examples I'll show you today, the process was proprietary when it was brought to the government and the government is—is trying to exploit that technology. And so in that case, that technology is owned by the company.

It depends upon who paid for the development of the technology.

Classification is used only in the case of when we feel getting that technology into our adversary's hands would be detrimental to us.

Incidentally, I would comment on that, that the majority of materials technology is built around process and know-how, and so that composition is not always sufficient to reproduce a material in the same way.

So I'll go on with my statement.

Mr. McCURDY. So is the process—would the process be classified?

Is the process—how you manufacture would be the——

Dr. KERBER. The process is usually proprietary or it is usually not accessible in open literature.

Mr. McCURDY. They're protecting themselves——

Dr. KERBER. That's right.

Mr. McCURDY [continuing]. In other words, from a competitive standpoint as opposed to the national security issue?

Dr. KERBER. You're correct.

The final area I wanted to touch on is rapid solidification technology. And we have initiated in 1980 a comprehensive program in this area, and we have made significant progress and are now emphasizing high temperature aluminum and titanium alloys. We have had success in melt extraction, melt spinning, gas atomization, and we feel that we have made very significant progress in the RST process.

We are now able to use titanium aluminides and are to achieve maximum temperature and strength capabilities in both aluminum and titanium alloys.

This really ends the majority of what I want to say. I wanted to do two things: I wanted to indicate to you that we have a strong Materials and Structures Program in the Department of Defense, and I think it's a critical and enabling technology for us. I think it is well managed. I think it is very well coordinated throughout the

Federal Government, and we plan to continue to keep the program in that state.

I would like to show you a few examples of materials so that you can get some firsthand knowledge of the kinds of things that are being developed and used within the Department.

I have a few examples here.

[Materials demonstration.]

Dr. KERBER. The first one is a 3D carbon/carbon. Now, composites, in general, are laminated structures, such that you lay up a fiber in one direction and then another direction so that you get certain material properties and then you impregnate that with what we call a matrix.

This particular carbon/carbon not only has that two-dimensional structure but it has a weave so that it is three-dimensional so that the plies don't easily pull apart—so it gives it three dimensions of strength.

So we'll pass that around.

This technology , of course, can be used in either reentry vehicle nose tips or in rocket nozzles or the other applications I mentioned to you.

The next one I wanted to show you is a really clever aluminum oxide aluminum cermet, and this is a simulated gun barrel. And the significance of this is it's net shaped processing, which means that it was formed in this shape, so that you have minimal machining to get it into, say, a gun barrel. This happens to be a proprietary process as you were indicating before.

This is owned by Lanxide Corporation in Newark, Delaware, and we are very excited about exploiting this technology. This is a DARPA program and the success of this will be to make things that are longer lived, they're stronger, higher—more significant a lifetime than we've had in the past. So I'll pass this around. It's a very—very significant development.

The next one I wanted to show you is clever in the sense that this is a material that has what we call zero coefficient of thermal expansion. And by that I mean between—in this case it's between minus 150 degrees Fahrenheit and plus 250 degrees Fahrenheit. This material won't change—won't expand or contract when subjected to those temperature differentials.

The significance of that is, for example, if you have this structure in space—and this room seems to be full of space pictures—it won't expand, or contract, or deform, based on the fact that it has, say, the sun on one side and is hot, and is cool on the other side when it's exposed to deep space.

Now, this is done by basically taking the material—in this case, it's a cast magnesium matrix with a graphite fiber, and the fibers are just put at the right orientation, so you get this zero coefficient of thermal expansion.

This is just using materials technology and structures technology to, in the sense, engineer materials that perform as we like. I think it is a real success story.

And the last one is—is the one that is sort of the hottest topic of the day, and that is—you're familiar with the testimony that we just had relative to higher temperatures for superconductivity.

And this material I have in front of me is a thin film that was made—its solanthium, stronium, copper, oxide. It was made by Rockwell Science Center, and it has a particular—in this case it has a critical temperature of 50 degress Kelvin which is, oh, say, maybe minus 350 degrees Fahrenheit. That is compared to 4 degrees Kelvin which was the—the liquid helium temperature that was talked about earlier.

There are materials now—not—it doesn't happen to be this one, but there are materials now that have temperatures that go up into a 100 degree Centigrade or say minus 300 degrees Fahrenheit—in that range. That allows us now to use liquid nitrogen as a coolant rather than a liquid helium.

So this is an advance—advancement that we're taking advantage of—and many of our systems. We see many opportunities not only in computing systems but in—in electric motors and various current carrying systems where we have to worry about rejected heat now. And when—when we have a superconductivity material, we will no longer have that heat generation problem powerless.

So I think this is really exciting. In fact we're going to shift some resources to take advantage of this technology.

Mr. Chairman, that ends my formal comments. I'd be happy to answer any questions you have.

[The prepared statement of Dr. Kerber follows:]

Mr. Chairman and Members of the Committee: It is my privilege to meet with you today to discuss the Department of Defense's Advanced Materials Research and Development program. I am accompanied by Mr. Jerome Persh, my Staff Specialist for Materials and Structures, who is available to answer questions in his areas of responsibility.

As Deputy Under Secretary of Defense for Research and Advanced Technology, I am responsible for the Defense Science and Technology program. This includes defense basic research, exploratory development and advanced technology development programs. These programs are the underpinning of the Department's acquisition process because they are the vehicles by which knowledge and know-how are acquired to provide our personnel and our forces with superior equipment to achieve military goals and objectives.

The technological advantages we possess today over potential adversaries are only temporary. The Soviets have long since realized that the communist ideology will not be a force for change in the future. They are now using military power to influence international events. They are willing to invest large amounts of national resources for new technologies and sophisticated systems for the projection of influence into various regions of the world. As the United States has traditionally relied on technologically superior equipment to overcome the larger numbers employed by potential adversaries, our national challenge is to develop, in a timely manner, technologies needed to maintain a believable deterrent and to prevent adverse technical surprise.

The Defense Science and Technology program meets this challenge by using both the public and private sectors to produce the technology for developing superior equipment. The program covers technologies of importance to national security and employes the facilities and skills of industry, the university community and government laboratories to achieve the Department's technical goals.

Defense Science and Technology managers have long recognized the importance of the Advanced Materials Research and Development program. Advancements in materials often are a prerequisite to advancements in other technologies. Reducing the weight of a missile gives the designer additional options in range, payload and performance. A warhead that can withstand the rigors of reentry velocities through adverse weather leads to improved accuracy. Higher strength and lighter weight materials are one of the essential building blocks for developing equipment with superior performance. However, increased military capability is not the only objective.

In addition to needing increased capabilities, it is equally important that affordability of the products produced by technology be considered. One of the great benefits of technology is that, if properly directed, it can lead to more affordable equip-

ment. Integrated circuits, software and materials programs are often undertaken not so much on the basis of can it be done but rather can it be done in an affordable components that in turn make possible the design and production of equipment with greater capabilities without sacrificing cost, reliability and supportability principles. We plan to move strongly in that direction.

Another criterion in the selection of material developments is unique to the military. Survivability on the battlefield is essential to the successful achievement of national objectives. Armor that can withstand high velocity warheads, sensors and optics that can withstand laser radiation and materials that can withstand the rigors of harsh battlefield environments are requirements that we must recognize. Our FY 1988 and FY 1989 budget request provides for additional work on survivability of our equipment and thus our forces.

The overall composition of the Materials and Structures program that I will discuss today is directed at structural, functional, and thermal protection materials with only a small portion directed at radome, antennae, and infrared window materials. Almost all of the electronic materials work is covered under our electron devices research and development programs. The funding request for the electronic materials portion of the overall program is $64 million.

A recent Defense Science Board Task Force on Semiconductor Dependency has highlighted the critical role that state of the art semiconductor devices play in our national defense posture, providing a 'force multiplier' to help us overcome the numerical advantage of our potential adversaries. Domestic electronic materials research was cited as a key element of the strategy to recapture world leadership in semiconductors which is so vital to both the nation's defense and U.S. industrial competitiveness.

Today's testimony will focus on the "non-electronic" materials efforts of the Department, but I will be happy to answer any questions you may have regarding our semiconductor and electronic materials programs.

Our request for the DOD materials research and development for FY 1988 is $339 million and for FY 1989 it is $384 million. We consider the program to be one of our most important science and technology efforts and intend to continue our strong support for it because of the opportunities it affords for improving our military posture.

An important aspect of our program is the coordination of efforts within DOD and also with other government agencies doing materials research and development. The Department has a three tiered science and technology review process. The first level requires my Staff Specialist to hold an annual tri-Service management review for the purpose of determining the technical, fiscal and managerial adequacy of his assigned program. These reviews are rather detailed and dwell on the relevancy of the work to military needs.

At my level, an annual investment strategy review is held with each Service to evaluate broader aspects of the Science and Technology program. Even though these reviews are held on a single Service basis, all Services attend and a healthy interaction takes place on the allocation of science and technology resources. And finally, highly specialized topical reviews are held in relatively narrow technical areas to define, provide status of and coordinate specific projects. This multi-level review approach provides an excellent means of evaluating materials programs within DOD.

The primary mechanism used for inter-agency program coordination is the working group format involving representation from agencies having a role in a specific technology area. Many materials projects involve the National Aeronautics and Space Administration and we work closely with them on numerous programs. Other activities include the National Academy of Sciences/National Materials Advisory Board and the Office of Science and Technology Policy/Committee on Materials Working Groups on Rapid Solidification Technology and Composites Standardization.

We also work very closely with the DOD Acquisition and Logistics Office on matters requiring a research and development input. As a matter of fact a DOD Composites Working Group is jointly chaired by an A&L staff member and a member of my staff. The issue of domestic availability of graphite fibers derived from polyacrylonitrile is the major topic of a study by this group. In addition, the results of much of our materials research and development is made available through the National Technical Information Service and DOD sponsored Information Analysis Centers. We will continue to emphasize program coordination both within DOD and with other agencies.

The DOD materials research and development program has produced a number of important advances that have resulted in a large number of major applications both in DOD and the private sector. It is not possible today to cover all projects within

the program but I will discuss those efforts in which the Committee has expressed an interest. I should also note that because our materials programs are intertwined with our structures efforts, my discussions will imply both the materials and structures elements of the total program.

ORGANIC MATRIX COMPOSITES

The organic matrix composites developed by DOD have been successfully transitioned to numerous major military applications. Practically every military aircraft in the free world is using this material in some portion of their airframes. The V-22 Osprey, a new development, will use composites in about 60 percent of the airframe. In addition to airframes, extensive use of these composites has been made for both strategic missiles like the PEACEKEEPER and the TRIDENT and also for smaller tactical missiles. A similar pattern is emerging in the commercial aircraft industry.

The world-wide consumption of these composites in 1984 approximated 22 million pounds. The major users are the aircraft, sporting goods, machinery and automotive industries. It is estimated that the organic matrix composite sector will grow at a relatively high rate over the next few years with production approaching the 200 million pound mark by the turn of the century. This has been a very successful technology transition effort to both the private and public sectors. Our future activities will involve wider applications of this material in order to reap cost and performance benefits.

METAL-MATRIX COMPOSITES

The Department became interested in metal-matrix composites as a result of studies done by the National Academy of Sciences/National Materials Advisory Board and the Institute for Defense Analyses during the 1970s. The need for higher strength and stiffness composites were the driving factors. A Tri-Service/DARPA thrust in metal-matrix composites was launched in 1979. The technology base that has been built up over the intervening years is beginning to bear fruit. The Strategic Defense Initiative and the National AeroSpace Plane will make extensive use of this technology in achieving their objectives. It is anticipated there will be a continuing use for these composites in specialized and demanding situations. Industrial use is sure to follow as improved properties and affordability factors evolve.

CARBON-CARBON COMPOSITES

The DOD has a long history of carbon-carbon research and development to meet very demanding military needs. This material has been used as thermal protection for re-entry vehicles and rocket nozzles. Most all military aircraft use carbon-carbon composites for brakes because of the lightweight and long wearing characteristics. The use of this material in hot sections of gas turbines is most promising. We have launched the Integrated High Performance Turbine Engine Program (IHPTEP) to demonstrate technology at the turn of the century that will double propulsion capabilities for aircraft and missile applications. The success of this program, in a large measure, will depend upon the development of coatings for carbon-carbon composites to be used in hot sections of engines.

ADVANCED STRUCTURAL CERAMICS AND CERAMIC MATRIX COMPOSITES

The military departments and DARPA have addressed monolithic ceramics for high temperature gas turbine structural components for a number of years. However, the demands that we see now will require compositing. Improvements in fracture properties have been obtained by reinforcing with both discontinuous and continuous, high strength fibers. The most advanced ceramic matrix structures to date are silicon carbide fiber-reinforced glass/ceramic matrices.

Ceramic matrix composites present an opportunity to design composites for specific engineering applications. Much research and development needs to be done on new high-temperature fibers that can be processed with a range of matrix materials We will continue to support ceramic composites research and development because of the potential it has for solving demanding problems facing systems in the coming decades.

RAPID SOLIDIFICATION TECHNOLOGY/ADVANCED METAL-ALLOY SYSTEMS

In 1980 we initiated a comprehensive program to rapidly advance the state-of-the-art in materials processing through Rapid Solidification Technology (RST). The objective of this program was to develop metallic materials having significantly im-

proved properties over those conventionally produced. We have made significant progress and are now emphasizing high temperature aluminum and titanium alloys. Melt extraction, melt spinning, and gas atomization are being examined as the preferred RST processes to achieve the higher cooling rates. Work on titanium aluminides is being pursued to achieve maximum temperature and strength capabilities in both aluminum and titanium alloys. Oxidation resistant niobium alloys and corrosion resistant magnesium alloys are also being sought using the RST process to extend alloying and metallurgical structure possibilities.

I hope that I have conveyed to you an understanding of the DoD Advanced Material Research and Development program. It is our view that advanced materials, both electronic and structural/functional, are essential limiting factors for the development of new weapon systems. Their development can lead to entirely new military capabilities not previously available. Because of this we will continue to give these areas special attention from my office and maintain direct oversight. We plan to select and pursue material projects that will form the basis for improving performance, survivability and cost of future defense equipment. In recognition of the value of the materials program, we work hard to ensure it is well managed and meets the needs of the Services and Defense Agencies in their quest of National Security goals.

DOD MATERIALS AND STRUCTURES TECHNOLOGY

[In millions of dollars]

	Fiscal year—			
	1986	1987	1988	1989
Amry	39	44	35	38
Navy	67	73	77	80
Air Force	72	113	129	138
Defense agencies	33	37	35	42
URI	5	10	10	[1] 15
SBIR	[1]30	[1]30	[1]30	[1]30
SDI		14	23	41
Total	246	321	339	384

[1] Estimated

ESTIMATE OF TOTAL DOD MATERIALS AND STRUCTURES TECHNOLOGY IN AREAS OF COMMITTEE INTEREST

[in millions of dollars]

	Fiscal year—			
	1986	1987	1988	1989
Ceramics/Ceramic composites	13	34	34	40
Advanced Composites:				
Organic matrix	32	55	55	65
Metal matrix	25	40	40	51
Carbon/carbon	21	20	20	30
Rapid solidification	11	13	15	20
Total	122	162	164	216

OTHER AGENCIES MATERIALS AND STRUCTURES TECHNOLOGY

[in millions of dollars]

	Fiscal year—		
	1984	1985	1986
Department of Energy	396	432	374
National Aeronautics and Space Administration	89	107	97

OTHER AGENCIES MATERIALS AND STRUCTURES TECHNOLOGY—Continued

[in millions of dollars]

	Fiscal year—		
	1984	1985	1986
National Science Foundation	122	142	150
Department of Commerce	17	23	31
Bureau of Mines	30	33	25
Total	654	737	677

Mr. McCURDY. Well, Dr. Kerber, we—I appreciate your testimony. And having worked with you in the other committee, I'm—I'm very familiar with your expertise and your capabilities. And I concur that the DOD program is a robust program and I think it is well coordinated within DOD. And I think the issue that I had raised with you in one of the Armed Services meetings with Dr. Graham was the coordination throughout the government as opposed to just DOD.

And it's not—it's certainly not a slap at DOD or you. It's just that the Federal Government seems to have either greater applications or certainly a deeper pocket for Defense R&D than they do in some other areas. And—and I just am concerned that we—that we spread the research that—I'm not saying cutting yours. I'm just saying that other areas need to be elevated in—in the relative priority. And hope that these other—well, basically, the Science Adviser and others would insure that those efforts are being done.

The——

Dr. KERBER. Could I make a comment on that, Mr. Chairman?

Mr. McCURDY. Certainly.

Dr. KERBER. Two points. As I indicated earlier, there is very strong coordination and it's at the Program Manager level. And I was a part of that, and I think it works very well.

The other thing is, if you look in that prepared testimony you will see that there is a chart that indicates the funding. And in the past that we had record of in the other Federal agencies, and Defense would represent only about—and I'm talking now Defense Materials and Structures—is about a third of—of the total national budget if you looked at the others and materials.

If you just look at—looked at Defense and materials area alone, then we would be less than a third of the national funding in—in that—in materials area.

So I think we have a strong, healthy program but we do need to coordinate with Energy, and we need to coordinate with Commerce, and we need to coordinate with the National Science Foundation. And we do it very successfully.

Mr. McCURDY. Very good. I'm glad you have that chart.

I think our discussions in the other committee were—were fruitful.

Dr. KERBER. Okay.

Mr. McCURDY. I appreciate your anticipation of those questions.

The—what is the process by which when DOD—does DOD actually coordinate meetings on composites and ceramics, or is that—

are those just general meetings held either through scientific associations or whatever, and DOD participates, or do you actually initiate those kinds of programs?

Dr. KERBER. We initiate those every year in the critical areas. In fact, Mr. Persh has topical review meetings in all the critical technologies, and when we see something that needs some attention and—for example, yesterday I had in my office people looking at hardening technologies, developing technologies to harden against various weapons systems, developing new materials to do that.

When we see a problem, we bring that to the—to the office, so to speak. And we bring all the players in and we look at all the programs, and we coordinate that. And in—in the case of the hardening effort, we made an issue of it last year in the budget cycle and we put new money in it.

In the case of the composites area, those are very well coordinated, those are organized national meetings—national Federal only meetings, primarily for DOD, that we run every year in—in the most important topical areas.

Mr. MCCURDY. What do you mean by national Federal?

Dr. KERBER. National, well, meaning that we have the Federal reps in from each of the services and DARPA to present their program in the—in these critical technologies and the materials area.

Mr. MCCURDY. Do you have—

Dr. KERBER. And we will—we will invite, for example, NASA and NSF, and DOE, to come and—and—

Mr. MCCURDY. Do you have private—private—

Dr. KERBER. Well, it's not for industry because we're looking at our own strategy.

Mr. MCCURDY. Just your own strategy.

Do you have—do you have broader meetings to include industry to—

Dr. KERBER. Yes, we do.

Mr. MCCURDY [continuing]. Disseminate the information, or I guess cross-fertilize, or whatever?

Dr. KERBER. We have major technical meetings in—in, for example, metal-matrix composites, we had one in spacecraft structures. I'm just thinking of ones that come off the top of my head. We've had them in—in hardening technologies. We have them in composites. We—we organize many meetings in the Materials and Structures area all through the year.

Mr. MCCURDY. How do you handle foreign reps in those kinds of meetings? How do you—what kind of criteria do you use?

Dr. KERBER. In certain meetings or certain sessions that are restricted to U.S. only, and certain meetings they are classified. So the material is classified and you must have a valid security clearance presented to the host organization in order to attend that meeting.

Mr. MCCURDY. The—in one of the, I guess in the ceramics technology in—no, it was in the alloys, in the metal alloys, in your testimony, the rapid solidification technology—some years back I visited one of the major contractors—Wyman Gordon—that had the press, in effect, and we were finding at the time that there was a real bottleneck created, because only one or two companies had the ability to, for titanium and for forging, basic forges.

Is—are the efforts here to not only expand the production or is to move away from those kinds of requirements, or do these have major forging requirements?

Dr. KERBER. While you're developing a metal structure, but you're developing a metal structure with unique properties because you're doing this rapid solidification. But you still have the——

Mr. MCCURDY. Forging requirements.

Mr. KERBER. You still have to form the material. In some cases, you can net shape it.

Mr. MCCURDY. Those are potential bottlenecks, though, and——

Dr. KERBER. Well, if we—if we're going to go into that detail I would like to ask Mr. Persh to respond, perhaps.

Mr. MCCURDY. You recall, Mr. Persh, that a few years back when we were trying to get titanium forgings for aircraft, we were finding that there was long—long lead requirement, lengthy delays, and major problems there, which drove up the cost and had all kinds of repercussions in the procurement system.

Is that still a problem, and are we doing anything to move away from that?

Mr. PERSH. No. Rapid solidification is not going to solve that problem. It's a new technique for producing powders which are extremely pure and yield higher strength corrosion-resistant metals. But, as Dr. Kerber said, the final fabication of large pieces to forging techniques will require presses, large presses. And it would be very difficult, from my view, to net form a large wing box, say, from an aircraft, by rapid solidification. You are going to have to make a big billet, and you're going to have to forge it to some shape which you can machine.

So, RST is not going to solve that forging problem.

Mr. MCCURDY. Who—who would—this is just a basic question, it's not directly related to the R&D effort, but it's still a concern that I have and I think it's a materials issue that—for the country—and that is, if we only have two major forges, and we—if we're ever to get into a bottleneck, is there—what—what secretariat level or who would be in charge of keeping track of the flow of materials and the ability to—to get these items out?

Dr. KERBER. Dr. Robert Costello, who is our new Assistant Secretary for Production and Logistics, has the responsibility for those areas.

Mr. MCCURDY. So it's a new function—office?

Dr. KERBER. It is not a new function. He is a new——

Mr. MCCURDY. It's a new person——

Dr. KERBER [continuing]. New person in that office.

Mr. MCCURDY. Costello?

Dr. KERBER. Costello.

Mr. MCCURDY. Okay.

We—in the session that you and Dr. Graham and I had, I raised the issue of Mantech, and—are there any Mantech program monies included in—in your funding levels in this R&D?

Dr. KERBER. There are not. I would indicate that the Mantech funding level of, let's see, is about $165 million is the Mantech funding level.

Mr. MCCURDY. 165 million?

Dr. KERBER. Yes.

Mr. MCCURDY. For this year?

Dr. KERBER. That's——

Mr. MCCURDY. That's Air Force, or is that——

Dr. KERBER. Well, it's primarily Air Force. I—I would have to check for you and I would do that for the record on where all those monies are, but it was, I believe——

Mr. MCCURDY. That's down then?

Dr. KERBER. What?

Mr. MCCURDY. That's down?

Dr. KERBER. No, I think the—the number that was thought in the earlier hearing that was quoted—incidentally, not by me—was too high.

Mr. MCCURDY. I quoted the number but I—I specifically recall because I—I zeroed them out two years ago to get the attention of the—of the Department on—on those items. And I can assure you, they quickly came to light thereafter. And I learned a lot about Mantech at the time.

Dr. KERBER. I——

Mr. MCCURDY. And—and I'm not opposed to Mantech. I'm—I'm now a fan of Mantech. But at the time in the hearing, no one could tell me what Mantech was and where the money was going. And we were looking at significant dollars—it was over 300 million.

Dr. KERBER. Well, Dr. Costello——

Mr. MCCURDY. Well, we were looking at—what we do, we were looking at each agency and we kept going through, and all of a sudden there's one in Air Force, and there was over in Army, and all of a sudden there was one over, you know—and we kept going, and each time there's another hundred or so million popping up. And so we said, wait a minute, we want to get a handle on this.

I support Mantech. I'd like to see it utilized in other areas, not just DOD—that was my point.

Dr. KERBER. My staff checked into this and my impression is that the number for 1987 is $124 million, and it's $165 million in 1988. That does come under Dr. Costello's jurisdiction.

Mr. MCCURDY. Good.

Dr. KERBER. There are some Mantech types of activities that we conduct in R&D because, as I indicated in my opening statement, affordability is a key issue for technology. So in certain circumstances we will look at manufacturing technologies in order to make something we've discovered affordable. But it is not—it is not driving it to the factory floor like he would do.

Mr. MCCURDY. It's the difference between processes and manufacturing capability? I mean, how do you separate that—that——

Dr. KERBER. Well, we're trying to develop the science, if you will, of manufacturing, and then that has to be passed on to the factory floor by developing it—you know, a capability for—for exploiting that technology. It's a fine line.

Mr. MCCURDY. Once that is passed on, then who owns that—like, does the government own the process? Mantech?

Dr. KERBER. Yes, we——

Mr. MCCURDY. And do you disseminate that to other contractors, I guess at the time, or do you do it government-wide?

Dr. KERBER. In fact, if we do that, that has been a continuing issue so that when we multi-source DOD equipment that we can pass that technology from one contractor to another.

Mr. MCCURDY. Of the 300-and-some-odd-million in total materials research—339—how much of that would be university?

Dr. KERBER. Well, let's see, I think there was indicated about $10 million there on the university research initiative.

Mr. MCCURDY. Just on the research initiative?

Dr. KERBER. Yes. And then I recall that the number was for basic research in materials which was associated with the number I gave you for the other Federal agencies—that was about $97 million. So I could approximate that to say that the number is probably in basic research on the order of $100, $110 million.

I could answer that specifically for the record if you like.

Mr. MCCURDY. It's basically a third of your materials research would be conducting basic research——

Dr. KERBER. That's basic research. Now, that is not all done in universities. It's basic researches conducted in universities and it's also conducted in industry and in DOD labs.

Mr. MCCURDY. Okay.

Dr. KERBER. I think if you want a precise number it would be better——

Mr. MCCURDY. Well, I've been interested, as you know, and I was one of the two authors of the University Research Initiative in R&D and have been concerned about that program. But I understood there were other components of university research in this.

Dr. KERBER. Oh, there are. For example, in—there definitely are. But in the University Research Initiative, I think we have in—in steady State funding, if you will, about $15 million per year in structural materials and about the same amount in electronic materials in the University Research Initiative.

Mr. MCCURDY. Very good. I've consumed too much of the time. The gentleman from Maryland?

Mr. MCMILLEN. Thank you, Mr. Chairman.

I would like to address some of the questions on composites.

Is it currently a clear policy on the use and need for domestically produced carbon fibers for military use? Is one being prepared and when will it be available?

Dr. KERBER. Well, we already have a policy which was issued I believe in 1986. That policy said that the Department will purchase one-third of the material which I think you are referring to, which is PAN, within—by—by 1988, from domestic sources.

Mr. MCMILLEN. A recent estimate suggests that military airframes in advanced tactical fighter, for instance, will exceed 75 percent in advanced structural composites.

Do you agree with this estimate, and what are the problems in using these materials? Maybe you could delineate that a little bit.

Dr. KERBER. Well, the V-22 Osprey has approximately 60 percent structural composites, which is the highest percentage that I'm currently aware of that is on the drawing boards, if you will.

Mr. MCMILLEN. Sixty percent?

Dr. KERBER. That's about 60 percent.

We view the use of composites as being—it gives us several things: It gives us higher strength for the weight. It usually gives

us higher stiffness. There could be other advantages. So we see the—the use of composites expanding as time goes on.

One of the major project—problems with the exploiting composites is the ability to manufacture them in a reproducible way to have nondestructive evaluation techniques to monitor them, to repair them in the field. So I think in the future that things we'll be working on will be processing technologies. We'll be working on nondestructive evaluation technologies and things of that nature. In fact, I would suggest that one of your next witnesses, Dr. Byron Pipes, who is at the University of Delaware with their Composite Center, is doing work in areas that support us in this technology.

Mr. McMillen. Of the 200 million pounds of matrix composites estimated for the year 2000, how much of that would you estimate will have military use, and what dollar value would you estimate?

Dr. Kerber. You've asked me a hard question, which I will probably have to answer for the record. Although I will tell you in a qualitative way that I expect the use of—of organic matrix composites to explode in the commercial sector relative to the military sector. That's where we see the primary growth. I expect that DOD use to grow but I expect the commercial sector to expand tremendously in the use of—of composites. There are certainly all kinds of areas, from sporting equipment to appliances, to automotive—all of those industries are aggressively looking at composites. They give them many, many advantages-reduce the parts count. They—usually you don't—don't have corrosion problems. It's—it's just the way the materials technology is going.

Mr. McMillen. Do you see downstream a concern expressed by industry with their ability to compete with cheap fiber imports? And do you share that concern?

Dr. Kerber. I'm very concerned about us having domestic sources. And the Department has the policy I indicated—the Department is reviewing that policy at this time.

Mr. McMillen. What—I mean, can you—can you expand upon that Federal role for providing domestic availability?

Dr. Kerber. I don't know what you mean by Federal role for domestic availability.

What we're trying to do in Defense is look at assuring that from a national security point of view, we have the materials that we need for our systems.

There is a bigger problem which you are alluding to, which is national dependence from the commercial sector on materials technology. I think it's an important issue. It can only help Defense if we have a strong industrial base and have that market. But it really isn't a Defense issue.

Mr. McMillen. It's interesting—when I was reading this article, a study of Japan, 1981, projected by the year 2000, Japan's market for advanced industrial materials would be about $34 billion at current rates of exchange. That's really remarkable when you think about the magnitude and the growth curve that exists there.

I guess in other—other lines of questioning, and other witnesses, my concern is that, you know, are we ceding leadership here? Are we—are we doing enough to make sure that we have our own capability in hand in this country?

Dr. KERBER. Certainly we are trying to. I can tell you that I was in Japan I think in—in November time frame, and they are very aggressively moving in all areas of technology: electronics, materials. And that's not to—to say that they shouldn't do that. That's an aggressive policy by the Japanese, and they should be applauded for it.

What we need to do in this country is to—to do the same thing. And we in Defense are certainly trying to assure that—that our sources are secure and that we have the best and the latest technology in this country for defense systems.

Mr. MCMILLEN. Is there some contradictions or some competition between the domestic and military sectors in the sense that information is being withheld, knowledge is being withheld, by the military that could be important in the development of—of these materials commercially?

Dr. KERBER. Oh, I don't—in fact, I think it's quite the contrary. I think the fact that we have a strong Defense Materials and Structures Program, and the fact that I indicated to you that only 10 to 15 percent of that is classified means that that program is really feeding not only the defense sector but it's also feeding the private sector. And it's up, frankly, to the industries and the private sector to capitalize on those markets.

Mr. MCMILLEN. So you don't see that as a problem in our country?

Dr. KERBER. I think the fact that we have a healthy R&D program under defense is exactly what we should have.

Mr. MCMILLEN. And that information is fairly shared with the private sector?

Dr. KERBER. The information is primarily in the private sector because they are our contractors.

Mr. MCMILLEN. Is the problem with regulating non-classified information?

Dr. KERBER. There are some regulations on non-classified information. However, there has been a recent—and directive from the National Security Council relative to that kind of information.

Mr. MCMILLEN. The—I think that really gets to the crux of my questions which were basically because we focus so much on military application and we withhold information because of basic security reasons, are we losing competitive advantages in the commercial sector? And I'd like to explore that a little more with other witnesses and so forth, because that is a concern that I have, and I appreciate the chance to address it.

Thank you.

Mr. MCCURDY. I thank the gentleman.

Dr. Kerber, we may have a few questions that we would follow up with in writing. I assure you they won't be lengthy if we do. We try to keep those to a minimum.

I appreciate your testimony and your appearance today, as always, and look forward to working with you in the future.

Dr. KERBER. Thank you. It was my pleasure to be here.

Mr. MCCURDY. Thank you, too, Mr. Persh.

Mr. PERSH. Thank you.

Mr. MCCURDY. Our next witnesses will be Mr. James Burns and Jon DeVault, Hercules Aerospace Company, and Dr. Byron Pipes, Dean of Engineering, University of Delaware.

Also at this point in the record, we'll have the gentleman from Florida, Mr. Lewis' statement included after—in the—his opening statement included in the record.

Gentlemen, we've got a question what all the bells are—yes, why don't we go ahead and begin with Mr. Burns first and we'll try to proceed.

STATEMENT OF JAMES N. BURNS, VICE PRESIDENT, MARKETING, GRAPHITE MATERIALS AND AIRCRAFT STRUCTURES, HERCULES, INC., SALT LAKE CITY, UT, ACCOMPANIED BY JON B. DEVAULT, GROUP VICE PRESIDENT, HERCULES AEROSPACE CO., AND R. BYRON PIPES, DEAN OF ENGINEERING, UNIVERSITY OF DELAWARE, NEWARK, DE

Mr. BURNS. Okay.

Mr. Chairman and members of the subcommittee, we do have a prepared statement for the record.

Mr. MCCURDY. They will be admitted into the record.

Mr. BURNS. Okay.

On behalf of Hercules, Incorporated, I thank you for the opportunity to provide testimony here today.

Hercules is a major supplier of carbon fiber composites and, therefore, we're going to strictly talk to carbon fiber composites today. And I think you'll hear some of the problems relative to a material which has been very successful in the marketplace and perhaps some of the areas where we need some help today.

In response to your request, your request letter, we divided our response into five categories. Now, we'll talk about the applications, the opportunities for applications as well as the problems; we'll talk about how the technology transferred into the marketplace; the problems that your security and defense classifications causes in the marketplace; what is our position in the international market and, last, we'll suggest some priorities for your research and development activities.

Compared to metals, composite materials offer significant performance advantages and opportunities for growth that are almost endless. Carbon fiber composites are already playing a major role in today's aerospace market. Principally, this happens because vehicle performance improvement is achieved through weight reduction. You heard earlier that the V-22 is 60 percent. That's 60 percent carbon fiber composite. The 1986 rewinging program is also carbon fiber composite. The material on the F-18, the F-16, the B1B bomber, and so forth, are all manufactured from carbon fiber composites.

Today, the world market for carbon fiber is 7 million pounds. I've heard very large numbers, and I assume within those large numbers perhaps glass composites were also included.

It is forecast to grow to 20 million pounds by 1995, which represents about a 17 percent annual growth rate. The U.S. market today is 4 million pounds of carbon fiber composite, or about 60

percent of the total world market. We feel that will hold at 60 percent through 1995.

The U.S. market today is 70 percent aerospace related as opposed to an industrial market. We see that staying at about 65 percent through the year 1995.

The major use of advanced composites is in the aircraft industry, and I'm talking carbon fiber throughout my discussion. We see this trend continuing well into the early 1990s. It is forecast that carbon fiber composites will use—be used in almost every branch of the military service for weapon systems. We see this in our everyday activities.

Large volume usage in the industrial segment, in our opinion, will not happen until mid to late '90s—1990s.

One of the problems that we see for this material currently—In order to penetrate the very large markets, we must address several issues that currently limit the market growth. We have a material that looks very attractive but there are some things that need to—need to be done for us to capitalize on this product.

First, and I think most important, is the cost associated with material conversion to finished hardware. Yes, the material is expensive but today the biggest expense is associated with building finished parts from that material.

Another issue centers around the ability to non-destructively inspect completed hardware, and to verify structural integrity and to identify the effects on damage. One of the most fundamental issues, we think, associated with the reluctance in industry to use composites is the lack of a consistent database and a central source of data such as that which exists today for metals in Mil—Handbooks.

And, finally, we must increase the number of university trained personnel to accommodate the forecast market growth.

Now, about technology transfer. I'd say carbon fiber has been very successful in moving from the lab to the marketplace. Transfer of carbon fiber material technology to the military applications has been excellent as a result of DOD requirements, their funding, and their requirements set for higher preformance weapon systems.

Commercial applications, however, need more encouragement and backing from government-supported programs. NASA-funded programs directed at technology transfer did help. Funding, however, for those programs has been severely cut and are not forecast to receive significant funding in the near future.

Now, what are the problems relative to classifications of Defense programs from a material supplier's standpoint?

The government security/defense classifications have not significantly impacted advanced material development. In fact, some of these very large volume potential programs have caused many material suppliers to spend their own discretionary funds in developing the needed new materials.

Perhaps an area, however, that needs to be addressed is in the area of data base, and let me talk about that. In using advanced composite materials for aerospace programs, a detailed understanding—a detailed understanding of the material performance characteristics is required in the form of a data base. A data base can cost

upwards to $5 to $8 million. I think that's the—about the average, if you'll look at some of the programs—the F-16, the F-18. In some cases, that may even be larger.

In most cases, these data bases are not transferred from company to company or prime to prime, and are not made available to the commercial market segment. Therefore, on military programs, data bases on the same material could be generated more than one time, and the commercial segment would also generate their own data base.

Now, a little bit about our competition on the international scene.

What you see today is that many of the U.S. suppliers of advanced carbon fiber composite materials are either foreign owned. I think if you look in the marketplace there have been companies from foreign countries buying up those people who are in the lead in this country in composites, or these companies depend on supply of raw materials from foreign sources.

Most all new weapon systems are using cara. components to improve vehicle performance. This extensive usage has given impetus to DOD policy that will specify a percentage of domestically produced materials for use on military programs.

The U.S. materials industry will respond to the DOD's request when a clear policy has been issued as to the expected usage of domestically produced material. Domestic produced PAN will result in higher carbon fiber product cost for a period of time while plants of reasonable size can be operated at efficient capacity levels. During this time period, U.S. suppliers would be at a disadvantage to imports if a DOD policy is not in place. To date, an official DOD policy on domestically produced polyacrylonitrile is not in place.

On export control—let's talk about a material now that has been very successful in the marketplace and successfully around the world.

Adequate controls, in our opinion, between Departments of State, Commerce, and Defense to prevent critical component—and I'm talking component—technology from being exported are not in place.

This is particularly difficult when the advanced composite components are deeply embedded in the sale of aircraft to foreign countries. In general, these countries all desire offsets—offsets for buying aircraft from the U.S. And for the most part, advanced composite component technology has been high on their offset list.

While insufficient controls exist on finished composite components, the U.S. Government has placed, in our opinion, excessive controls on the export of advanced composite materials. These controls reduce the competitiveness of the U.S. materials supplier on the world market.

My written document elaborates on these controls, and I will not go through that here.

Talk a little bit about foreign trade zones. In the case of Hercules, we do manufacture carbon fiber in the United States. However, we do import polyacrylonitrile from a joint venture plant that we have in Japan.

Foreign trade zones established at a U.S. materials supplier facility would increase our competitiveness in the international marketplace.

Establishment of a sub-zone would allow U.S. manufacturers to pay duty based upon their final product—carbon fiber—as is the case for our competitors, importing materials to the U.S. directly as carbon fiber.

Again, details on a foreign trade zone and, in our opinion, the discrepancy between what we're being charged on duties versus competitors importing all carbon fiber products is detailed in the documentation.

We think another area that needs to be reviewed is the duty on precursor. The duty applied to carbon fiber products and the polyacrylonitrile mentioned earlier should be reviewed. These products were classified under existing duty schedules for convenience of U.S. Customs. Review the duty classifications I think on advanced composite materials is warranted in light of improving U.S. competitiveness.

Now, last, I'd like to comment on perhaps some ideas for research and development. To promote the growth of the U.S. composites industry, it is recommended that the government support the following types of research and development:

One: We need more enabling technologies for automated manufacture of finished composite structures. What I'm talking about there is taking the material and ending up with finished parts that are affordable.

Second: Application technology development is needed to provide required confidence and data bases to move advanced composites into the non-aircraft aerospace market as well as commercial markets.

Third: I believe we need to have programs at universities that will provide the trained manpower required to transfer material technology to the industrial segment, promote new applications and bring these applications to a cost competitive production status.

And last, I would like to see development of common data bases similar to those that exist for metals.

We'll take questions at this time.

[The prepared statement of Mr. Burns follows:]

TESTIMONY TO THE U.S. HOUSE OF REPRESENTATIVES

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

ON

ADVANCED MATERIALS

BY

JAMES N. BURNS
VICE PRESIDENT, MARKETING
GRAPHITE MATERIALS AND AIRCRAFT STRUCTURES
HERCULES, INC.

MARCH 31, 1987

TESTIMONY TO THE U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

Mr. Chairman and members of the Subcommittee on Transportation, Aviation and Materials, on behalf of Hercules Incorporated I thank you for the opportunity to provide testimony relative to the Sub-committee's inquiry on Advanced materials. Hercules is a major supplier of carbon fiber composite materials and structures to the aerospace market. My presentation today will focus, therefore, on carbon fiber composites only. The presentation will be divided into five categories as follows:

1) Applications
2) Technology transfer to the marketplace.
3) Problems associated with security and defense classifications.
4) U.S. position in international competition.
5) Suggested priorities for U.S. research and development.

I
APPLICATIONS

(A) Opportunities

Compared to metals, composite materials offer significant performance advantages and opportunities for growth that are almost endless. Through continued research and development, material performance and cost as well as manufacturing technology for structures using these materials will provide new applications in military and commercial markets.

Carbon fiber composites are already playing a major role in today's aerospace market. Principally, because improved vehicle performance is achieved through weight reduction compared to metal structures.

Today the world market for carbon fiber is 7 million pounds and is forecast to grow to 20 million pounds by 1995 (17% annual growth rate). The U. S. market today is 4 million pounds or 60% of the world market and is forecast to hold at about 60% of the world market through 1995. The U. S. market is 70% aerospace today and will remain over 65% aerospace through 1995. Foreign companies producing carbon fiber composites consider the U. S. aerospace market a primary target for their products because it is the largest, most advanced and most attractive relative to sales/profits. The 2nd largest world market is the Far East where carbon fiber products are used in manufacture of sporting goods.

The major use of advanced composites today is in the aircraft industry. We see this trend continuing into the 1990's. Carbon fiber materials are also playing a major role in strategic missile hardware and are forecast to move into weapon systems for all branches of the military. Space applications will use large amounts of composites in the heavy lift launch vehicles required to put large payloads into space during the 1990's. Composite structures application in the marine industry will emerge during the late 1990's. Large volume usage in the industrial segment is forecast for the mid to late 1990's.

B) Problems

In order to penetrate these large markets, we must address several issues that currently limit market growth. First are the costs associated with material conversion to finished hardware. To put this in perspective, carbon fiber pricing is $15.00 - $20.00 per pound today. Prepreg made from this fiber sells for $35.00 - $40.00 per pound, but the finished structure cost is between $250.00 and $600.00 per pound for aircraft components. Another issue centers around the ability to nondestructively inspect completed hardware to verify structual integrity, and to identify the effects of damage. Repair of damaged components is a technology that is closely associated with these issues and also must be addressed.

One of the most fundamental issues associated with the reluctance to use composites is the lack of a consistent data base and a central source of data such as what exits today in Mil-Handbooks for metals.

Finally, we must increase the number of university trained personnel to accommodate the forecast market growth.

II
TRANSFER OF TECHNOLOGY TO THE MARKETPLACE

Advanced composite material research and development has made great strides over the past several years. The impetus for this effort has come from the U.S. aerospace industry. The desire has been to improve vehicle performance. Generally speaking, performance improvements have come from weight reductions to the aerospace vehicle.

Transfer of carbon fiber material technology to military applications has been excellent as a result of DoD's requirements and funding for higher performance weapon systems. Commercial applications, however, need more encouragement/backing from government supported programs. NASA funded programs directed at improved aircraft efficiencies have provided the needed impetus to transfer technology to the commercial segment. NASA's programs helped to move advanced composites into commercial aircraft structures such as control surfaces, wings, fuselage sections, etc.. Funding, however, has been severely cut and these NASA sponsored programs are not forecast to receive future funding.

III
PROBLEMS ASSOCIATED WITH SECURITY/DEFENSE CLASSIFICATIONS

Government security/defense classifications have not significantly impacted advanced material development. In fact, some of these large volume potential programs have caused many material suppliers to spend their own discretionary funds in developing the needed new materials. The defense classifications do limit the material suppliers understanding of the market potential, but it has not significantly reduced the material industry's ability to respond.

In using advanced composite materials for aerospace programs, a detailed understanding of the material's performance characteristics in the form of a "Data Base" is required. A "Data Base" can cost upwards to $5-8 million dollars. In most cases these "Data Bases" are not transferred from company to company and are not made available to the commercial market segment. Therefore, on military programs, "Data Bases" on the same material are generated more than one time and the commercial segment must also generate their own "Data Bases". Large aerospace primes developing commercial aircraft can afford to generate a "Data Base", but small commercial users cannot.

IV
U.S. POSITION IN INTERNATIONAL COMPETITION

A) Foreign Dependency

Many U.S. suppliers of advanced carbon fiber composite materials are either foreign owned (BASF, ICI, British Petroleum, Courtaulds) or depend upon supply of raw materials from foreign sources. Other than computers and electronics, advanced composites are the only aircraft technology where the U.S. holds a significant lead today. Many foreign owned companies are supplying materials to classified weapon systems. The U. S. lead is threatened by foreign ties.

Most all new weapon systems are using carbon fiber composite components to improve vehicle performance. This extensive usage has given impetus to a DoD policy that will specify a percentage of domestically produced materials must be used for manufacture of military carbon fiber composite hardware. Today the precursor (PAN) for carbon fiber is the only foreign produced product used in U. S. produced carbon fiber materials. The U. S. materials industry will respond to DoD's request when a clear policy has been issued as to expected usage of domestically produced material. Domestic produced PAN will result in higher carbon fiber product costs for a period of time while plants of reasonable size can be operated at efficient capacity levels. To-date, an official DoD policy has not been issued.

B. Export Control

Adequate controls between Departments of State, Commerce and Defense to prevent critical composite component technology from being exported are not in place. This is particularly difficult when the advanced composite components are deeply embedded in the sale of aircraft to foreign countries. In general, these countries all desire offsets. For the most part, advanced composite components (parts) are high on their offset list.

While insufficient controls exist on finished composite components, the U.S. government has placed excessive controls on the export of advanced composite materials. These controls reduce the competitiveness of a U.S. material supplier on the world market.

The U.S. Commerce Department Regulations require that U. S. material suppliers obtain a license prior to exporting carbon fiber products and technical data relating to such products to markets outside the United States. The licenses for export of technical data are obtained in most instances by having the importing party agree in writing that it will not re-export the data to Soviet-bloc or embargoed nations. In instances where the technical data relates to manufacture of composite components, the material supplier files a license application with the Department of Commerce and obtains or seeks the written assurances, described above, as well.

With regard to certain applications of composites such as use in space structures or other potential military applications, the material supplier must seek a license from the State Department. Similarly, export of technical data relating to manufacture of carbon-carbon composites potentially useful in military applications requires a license from the State Department as well.

Applications filed with the Commerce Department to export technical data normally take about 40 calendar days from the date on which the application is filed. The whole process takes 50 days but requires considerable effort to maintain current with respect to the ever changing Commerce regulations. State Department regulations are not as changeable but answers to license applications have taken longer.

The U.S. Commerce Department also requires that U. S. material suppliers obtain written assurances that the direct product of technical data relating to component manufacture not be re-exported from the original country where it was exported by the U. S. material supplier. Thus, when the material supplier wants to export processing data to Aeritalia, for example, so that Aeritalia could build a wing for the European Fighter, the U. S. Department of Commerce has required that the material supplier obtain written assurance that the processing data and the direct product thereof not be re-exported by Aeritalia to any country outside Italy. The U.S. Department of Commerce has agreed in the European Fighter Program to written assurances that permit exchanges of data and/or direct product thereof among the Consortium partners only. Only Aeritalia among the European Consortium partners has agreed to written assurances as above described. Therefore, U. S. suppliers ability to sell to the EFA fighter aircraft program is difficult.

C) Export License

The procedure for obtaining a validated export license begins with the material supplier providing the prospective customer with a proforma invoice, which the customer requires to obtain an International Import Certificate or a Form ITA-629P. Generally the customer provides the material supplier with the applicable International Import Certificate or Form ITA-629P within three to four weeks.

Once the customer's International Import Certificate or the Form ITA-629P is received by the material supplier, the validated license application is prepared and submitted to the U. S. Department of Commerce. The validated license is usually issued by the Department of Commerce within twenty-four days.

The material supplier records the shipments on the back of the license and monitors the shipments to be certain that only the quantity authorized by the license is shipped. After the authorized commodity has been shipped, the material supplier returns the license to the Department of Commerce.

In summary, a shipment which requires a validated export license requires considerably more scrutiny and monitoring than a shipment which is not controlled. The added clerical procedures and follow-up activities increase the cost of U. S. produced carbon fiber products.

D) Foreign Trade Zone

Foreign Trade Zones established at U. S. material suppliers facilities would increase competitiveness in the international market place. The basis for a sub-zone savings are as follows:

1) PAN (Polyacrylonitrile) fiber is the precursor for carbon fiber. It is classified by U.S. Customs as an acrylic textile fiber product (TSUS Item 3093151) with a duty rate of 10.2% This duty rate was established to protect U.S. textile interests from foreign competition.

   The grade PAN used in our industry is definitely not a commodity textile product; yet, it suffers from being classified as such. The majority of PAN used in the manufacture of carbon fiber in the U. S. is imported from Japan.

2) Carbon fiber products such as those manufactured in the U. S. from PAN and those imported are classified under a carbon products category (TSUS item 5179100) with a duty rate of 5.6%.

3) The carbon fiber manufacturing process consumes approximately two pounds of PAN for every pound of carbon fiber produced. As such U. S. manufacturers are paying duty on material that is consumed and not saleable.

Establishment of the sub-zone would allow U. S. manufacturers to pay duty based on their final product, carbon fiber, on the same rate schedule as our foreign competition importing to the U. S. and only on the saleable product.

Public interest mandates the lowest cost products. Since at least half of DoD carbon fiber needs (not covered under a domesticity policy) may come from any source is it not in the taxpayers interest for the taxpayers to get the best deal for their money. Be assured that the large foreign-owned multi-national companies competing with U. S. suppliers will use their lowest cost sources.

Currently, only PAN is imported by Hercules. All labor and materials for conversion to carbon fiber comes from the U.S. as opposed to foreign sources where all operations are done overseas. Therefore, any of this

business Hercules can capture improves the U.S. balance of payments posture and the U.S. economy.

E) Duty on Precursor

The duty applied to carbon fiber products and PAN mentioned above should also be reviewed. These products were classified under existing duty schedules for convenience of U.S. Customs. As such, duty rates already in existence which are totally different for the two classes of products were applied. These rates may not be appropriate at all for either of these products. One could envision a separate duty classification for all advanced composite materials which would reflect the competitiveness in trade associated with our industry. PAN fiber is not a commodity acrylic textile fiber. It is a high purity specially spun product made specifically for our use. Likewise carbon fiber is not a standard carbon product. It is a product specifically designed and manufactured for specific applications. Review of the duty classification of advanced composite materials is warranted in light of improving U. S. competitiveness.

V
SUGGESTED PRIORITIES FOR U.S. RESEARCH AND DEVELOPMENT

Most government funded material research and development programs are aimed at a few exotic applications. These applications generally represent low volume potential and are areas where private industry is reluctant to spend their own discretionary funds to arrive at the needed products. For the bulk of DoD applications and all commercial applications, the users must generally go it alone. Enabling technologies are not keeping pace with advanced material development. To promote the growth of the U.S. composites industry, it is recommended that the government support the following types of research and development:

1) Enabling technologies for automated manufacture of finished composite structures.

2) Application technology development to provide required confidence and "Data Bases" to move advanced composites into the non-aircraft aerospace market as well as commercial markets.

3) Programs at universities that will provide trained manpower required to transfer materials technology to the industrial segment, promote new applications and bring the applications to a cost competitive production status.

4) Continued support of exotic new composite materials development for high temperature applications.

5) Development of common "Data Bases" similar to those existing for metals.

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Mr. McCURDY. Thank you, Mr. Burns.

Actually, we're going to have to take a short recess. Mr. McMillen went ahead and went to—to vote. As soon as he returns then Dr. Pipes will be recognized for his statement, then we'll do the questions jointly to the panel. He should be back in just a few minutes and we'll proceed.

[Recess.]

Mr. McCURDY. Dr. Pipes, I apologize for the delay. We had two votes instead of one so we had to—you know, back to back. That should finish it up for a while, though.

Dr. Pipes, thank you for coming in today and we appreciate your appearance and look forward to hearing your testimony.

Dr. PIPES. Mr. Chairman, I'm pleased to be here. I must say, though, that I believe that we are now preaching to the choir, that those of us that are still here are believers, and——

Mr. McCURDY. That's not unusual in this business, unfortunately, but at least we've got to print the song books, so let's—let's go through it.

Dr. PIPES. I'm happy to have provided a written statement for your committee.

Mr. McCURDY. It will be admitted in the record.

Dr. PIPES. Thank you.

In the spirit of the closeness of the time, I will make this synoptic as best I can.

I have a number of ideas to propose—perhaps more ideas than I have time, because many of the issues that have been raised here today, the issues of a—an evolving technology, a technology in which this country has developed and led internationally is under discussion—and there are many issues with respect to the maintenance of that leadership and the issues of international competitiveness, which I'd like—I'd like to speak to. I'll do my best to get to them as is possible.

Let me give you just a bit of an introduction in terms of the national perspective of this subject. You know, the initial impetus for a national emphasis on composite materials came from the need for new materials to meet extreme and exacting requirements of the aerospace programs of the 1960s. The demands on materials and these applications were so diverse and severe that no single existing material could satisfy the requirements.

Consequently, the ancient concept of combining several distinct materials into an integral composite system was revived as a means for fulfilling these needs. This persistent notion of composite materials was derived, undoubtedly, from the early observations of the efficiency of natural composite materials such as wood and bone, not to mention the straw filled brick.

The development of new stiff, strong, lightweight materials in fibrous forms, unified by advanced binders, played a key role in the success, both of the space program and the development of new military systems.

Today, while these materials continue to be important in these areas of application, significantly broader technological and economic roles are emerging to fulfill crucial national needs in the commercial sector.

It is becoming evident that materials have the potential—these materials have the potential to revolutionize the technologies associated with commercial aircraft, ground transportation, machine tools, industrial machinery, consumer products, and those industries which support those products.

Although composite materials are established in some applications, especially Defense, and their use is growing, the realization their full potential requires fundamental research and the nature of these materials in the part and tool design in the production methods and in product evaluation. I think those points have been articulated earlier.

The general scarcity of this basic information makes prediction of performance in terms of manufacturing parameters difficult. Even prediction of of short-term properties of newly-produced parts is by no means yet an exact science. And the prediction of long-term durability is even less so.

As a result, considerable trial and error is required in designing and testing prototypes before production. This procedure is expensive.

Advanced continuous fiber composites manufacturing methods remain highly labor intensive with only minor applications of automated methods. Thus, the key challenge, in my view, facing this important technology is to develop manufacturing methods and design methods which yield high performance properties from automated manufacturing methods.

A major challenge facing the academic sector is the training of engineers and scientists in sufficient quantity to insure and sustain the rapid adoption of this technology. It makes no sense to have a science base without manpower to utilize it.

Materials scientists are needed to assist in the selection and development of new materials, engineers are required to develop the advanced manufacturing procedures, and design engineers skilled in the treatment of these materials systems are needed to insure optimum utilization.

All of these disciplines should have a systems perspective geared to the understanding of the links between materials selection—manufacturing—and performance.

I'd like to bring to your attention a report authored by the U.S. Congress Office of Technology Assessment, which you may be familiar, which states that, the past 25 years have witnessed remarkable developments in structural materials technologies; new nonmetallic materials, such as ceramics and polymer matrix composites, are replacing metals in a wide variety of applications, ranging from cutting tools to tennis rackets.

The new materials represent both an opportunity and a challenge to the U.S. manufacturing industries. In an era of concern about long-term economic viability of the manufacturing sector—in the manufacturing sector—they open a promising avenue to renewed international competitiveness, new industries, and employment opportunities.

By the year 2000, large markets for ceramic and composite products will be found in not only military, aerospace, but also in automotive, medical, and construction applications.

However, these opportunities cannot be taken for granted. The United States does not enjoy a comfortable lead—indeed, it often lags—in new structural materials technologies; key advances continue to come from abroad.

Moreover, through well-coordinated government-industry efforts, several countries have succeeded in bringing ceramic and composite products to market year—years in advance of comparable U.S. products.

Japan in particular has initiated aggressive programs to commercialize its evolving materials technologies.

In order to realize the promise represented by the new materials, a consensus is—is developing in the materials community that the U.S. policymakers in government, universities, and industries will have to come together to define the feasible goals and materials applications, coordinate research and development efforts toward these goals, and, especially, focus on reducing the barriers to commercial introduction of advanced ceramic and composite products.

This is a—in some sense my primary theme today. And I offer you a—a new thought—a thought of technology transfer to the marketplace.

It is well known that the Department of Defense spends almost 80 percent of the total Federal appropriation for research and development. Following World War II, Defense expenditures in research and development led to significant advances in technology which improved the quality of life for both Americans and citizens of the entire Western world.

The opportunity for technology to trickle down from defense to the consumer fields was enhanced by the fact that America was without peer in the world. Hence, the time necessary for technology to diffuse from defense application to consumer product was available. Today, global competition has substantially reduced the time from technological innovation to consumer market. Competitive nations monitor innovations in technology and move developmets rapidly into the consumer products for worldwide markets.

There is little question that the world leadership today in science and technology remains largely in the United States. This is due in part to the significant investments in research and development made by the Federal Government. Yet, the results of the research and development conducted by the Department of Defense often find no direct path to consumer product forms or into the development of embryonic new businesses.

Of course, national security requires that defense applications of technology be safeguarded. However, I believe significant wealth in technology for consumer applications can be derived from basic research conducted by DOD without jeopardizing our defense requirements, while at the same time improving the position of America in global competition.

My proposal is the following:

Given the clear need to find new methods to take advantage of the significant national resources invested in research and development by the Department of Defense, it is timely to examine a single vehicle to translate this technology to the consumer industry sector. Consider the field of advanced composite materials as perhaps the field that one might demonstrate this process.

I mentioned earlier why these materials are important, and its also been mentioned that the advanced tactical fighter will use—project—will use a substantial part of these materials, or a proportion of these materials.

The challenge facing the application of these new materials in consumer fields is the lack of manufacturing technology sufficient to achieve economy consistent with the competitive consumer markets.

Today, advanced composites applications in the defense aerospace field are achieved through significant amounts of handwork, as was pointed out earlier. Clearly, technology involving significant amounts of labor-intensive steps does not conform readily to the competitive attributes of this country in the global competition.

Further, the variability of the product produced by—by strong—may be strongly influenced by the variability of the work force.

Therefore, the expansion of this technology requires the development of automated manufacturing systems, not only for economy of production in the commercial sector, but also for the reliability and reproducibility of defense systems.

So, automated manufacturing systems is the answer.

I propose the establishment of organizations which will provide for the rapid commercialization of worthy ideas generated through composites research and development supported by the Department of Defense.

Resources to support the organizations may well be provided jointly by the local State, industry, and university, as well as the Department of Defense and other Federal agencies. In addition to financial resources, human resources could be provided by the industrial sector and the university.

I propose the concept for the Institute for Composites Manufacturing and Commercialization—ICMC—which has been developed to respond to these needs.

In your enclosure I've shown a—a drawing, a schematic of this. This would involve a Design and Innovation Center, a Manufacturing Pilot Plant Research and Development Center, a Facilities Bank for Equipment and Instrumentation, and Incubator Space.

Ideas, financial resources, and human resources flow from the Institute—into the Institute—from the local industrial sector, the State, the local university, and the Department of Defense, and other Federal agencies such as the National Science Foundation.

In the Design and Innovation Center, modern computers and software are utilized by expert designers to complete design concepts which would be championed by a given entrepreneur.

In the Manufacturing Pilot Plant Research and Development Center, the manufacturing technology to produce the product design is developed.

Finally, equipment necessary to establish a small pilot plant is obtained from the Facilities Bank and established within the Incubator Space. After a suitable residence time within the Incubator Space, the new business is ready for designation as a commercial venture. It is then moved into a new site and receives additional investment—excuse me—required either by venture capital organizations or is acquired by established industrial organizations.

[The prepared statement of Dr. Pipes follows:]

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE
AND TECHNOLOGY

Subcommittee on Transportation, Aviation and Materials

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Room 2321
Rayburn House Office Building

R. Byron Pipes
University of Delaware

Advanced Composite Materials

R. Byron Pipes*
University of Delaware

NATIONAL PERSPECTIVE

The initial impetus for a national emphasis on composite materials came from the need for new materials to meet the extreme and exacting requirements of the aerospace programs of the 1960's. The demands on materials in these applications were so diverse and severe that no single existing material could satisfy the requirements. Consequently, the ancient concept of combining several distinct materials into an integral composite system was revived as a means of fulfilling these needs. This persistent notion of composite materials was derived, undoubtedly, from early observations of the efficiency of natural composite systems such as wood and bone.

The development of new stiff, strong, and lightweight materials systems consisting of high performance fibers unified by advanced binders played a key role in the success of both the space program and the development of new military systems. Today, while these materials continue to be important in these area's applications, significantly broader technological and economic roles are emerging to fulfill crucial national needs in the commercial sector. It is becoming evident that these

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* Vita attached

materials have the potential to revolutionize the technologies associated with the commercial aircraft, ground transportation, machine tool, and consumer products, and industries.

This revolution is driven by the technological and economic factors discussed in the following section. The challenges and competitions confronting this technology are given in the final section.

TECHNOLOGICAL AND ECONOMIC INCENTIVES

The term "composite" embraces any materials made up of two or more discrete components that combine physically to give enhanced behavior. In the early applications, the term composite material usually referred to arrays of strong, stiff continuous fibers bound together by a polymeric matrix. The broadened application of composite materials encompasses a wider range of fibers, binders and reinforcing geometries. The reinforcing material includes contemporary, as well as advanced glass fibers, organic fibers, inorganic fibers, carbon/graphite fibers, metal coated fibers, and whiskers. The binder phase may range from contemporary thermosetting and thermoplastic materials, advanced polymeric materials and ceramics, to metals. The reinforcing geometries included continuous fibers, two-dimensional textile weaves, three-dimensional textile weaves, chopped fiber rovings, dispersed short fibers, "whiskers", particles, and platelets. The combinations of these various reinforcing materials, binders

and reinforcing geometries can yield performance characteristics that cannot be achieved by the various components acting individually. In addition, such materials systems offer the advantage of design flexibility. In contrast to the traditional monolithic materials of construction, the properties of these multicomponent systems can be adjusted (through the control of composition and reinforcing geometries) to more efficiently match the requirements of specific applications. In order to fully exploit this potential for tailoring materials systems to end-use applications, the processes of materials selection, manufacturing, and structural design must be integrated. It is this integration of materials science, manufacturing, and design that provides the major technological incentive -- and challenge.

These technological advances are supported by strong economic incentives. The next generation of civilian aircraft is targeted to use composite materials for a large fraction of structural components with the intent of decreasing fuel consumption while increasing range and payload. The automotive and trucking industries have similar incentives to decrease fuel consumption and/or increase payload; however, the economies derived from parts consolidation through net shape manufacturing with attendant reductions in tooling and assembly cost provide additional incentives. Recent developments in the automotive industry indicate that composites will yield cost effective productions with fewer units than is now possible in contemporary steel construction. This major development will enhance the

competitive position of the United States automotive industry. Pontiac recently made good use of this advantage in the manufacture of its advanced design car -- Fiero, whose body panels are glass fiber and flake-reinforced polymer. In addition to a reduction in body panel weight, the corrosion resistant composite material offers enhanced durability over its metallic counterparts. The use of composite materials in sporting goods such as tennis racquet frames, golf club shafts, bicycle frames, and masts and spars for racing boats has brought composite materials into the public view. The superior performance of these materials in recreational equipment tends to establish consumer acceptance.

The high stiffness and strength-to-weight ratio of composite materials offers considerable potential for use in the machine tool industry. Increased productivity can be expected by taking advantage of the lower moment of inertia and the self-damping characteristics of these materials. Composite materials are being used for moving parts in textile machinery, where higher operating speeds and productivity are important. Separation efficiencies four times greater than that obtained by steel parts have been achieved. Composite materials show potential for use in robots and heavy construction machinery, where the low moment of inertia translates into more accurate control of positioning and lower energy cost.

This brief survey indicates that composite materials have technological applications and economic incentives to a number of industries that are vital to the national economy. It is reasonable to expect that the increased utilization of composite materials in these key industries will promote their use in other areas.

CHALLENGES AND COMPETITION

Although composite materials are established in several industries, and their use is growing, the realization of their full potential requires fundamental research in the nature of these materials, in part and tool design, in production methods, and in product evaluation. The general scarcity of this basic information makes prediction of performance in terms of manufacturing parameters difficult. Even prediction of short-term properties of newly-produced parts is by no means yet an exact science, and prediction of long-term durability is even less so. As a result, considerable trial and error is required in designing and testing prototypes before production. This procedure is expensive.

Advanced continuous fiber composites manufacturing methods remain highly labor intensive with only minor applications of automated methods. A key challenge facing this important

technology is to develop manufacturing methods and design methods which yield high performance properties from modern automated manufacturing methods.

A major challenge facing the academic sector is the training of engineers and scientists in sufficient quantity to insure and sustain the rapid adoption of this technology. Materials scientists are needed to assist in the selection and development of new materials, engineers are required to develop the advanced manufacturing procedures, and design engineers skilled in the treatment of these materials systems are needed to insure optimum utilization. All of these disciplines should have a systems perspective geared to the understanding of the links between materials selection - manufacturing - and performance.

The engineering and applications technology for advanced continuous fiber composites was initiated within the United States during the 1960's. Today the field of composite materials is an international enterprise. Many of the important fibers and resins are manufactured by and/or licensed from firms in other countries. Overseas activities in composites technology are rapidly growing. Indeed, Japanese and West European technologies rival, and in some cases, may lead the U.S. efforts. The foreign commitment to composite technologies is made evident by the MITI programs established in Japan and the federal programs in France, Italy, West Germany, Sweden, and the United Kingdom. For example, West Germany's composite research in institutes at

Aachen and Freiburg are being strengthened by a new Max Planck Institute for Polymer Science and Engineering in Mains. A broadly based academic-industrial program, initiated by MITI, is in place in Japan; this program currently supports university research in composite materials at a rate of $15 million per year. The maintenance of the United States' technical lead will require investments to insure the simultaneous development of the necessary manufacturing technologies, as well as graduates at the bachelors, masters, and doctoral levels sufficient to practice and advance this field.

PROBLEMS AND OPORTUNITIES

"The past 25 years have witnessed remarkable developments in structural materials technologies; new nonmetallic materials, such as ceramics and polymer matrix composites, are replacing metals in a wide variety of applications, ranging from cutting tools to tennis rackets. The new materials represent both an opportunity and a challenge for U.S. manufacturing industries. In an era of concern about the long-term economic viability of the manufacturing sector, they open a promising avenue to renewed international competitiveness, new industries, and employment opportunities.

By the year 2000, large markets for ceramic and composite products will be found in military, aerospace, automotive, medical, and construction applications. However, these

opportunities cannot be taken for granted. The United States does not enjoy a comfortable lead (indeed it often lags) in new structural materials technologies; key advances continue to come from abroad. Moreover, through well-coordinated government-industry efforts, several countries have succeeded in bringing ceramic and composite products to the market years in advance of comparable U.S. products. Japan in particular has initiated aggressive programs to commercialize its evolving materials technologies. In order to realize the promise represented by the new materials, a consensus is developing in the materials community that U.S policymakers in government, universities, and industries will have to come together to define feasible goals and materials applications, coordinate research and development efforts toward these goals, and, especially, focus on reducing the barriers to commercial introduction of advanced ceramic and composite products."[1]

Technology Transfer to the Marketplace

It is well known that the Department of Defense spends almost eighty percent of the total federal appropriation for research and development. Following World War II defense expenditures in research and development led to significant advances in technology which improved the qualify of life for

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[1]U.S. Congress Office of Technology Assessment, "New Structural Material Technologies: Opportunities for the Use of Advanced Ceramics and Composites." A Technical Memorandum, OTA-TM-E-32, Washington, D.C.: U.S. Government Printing Office, September 1986.

both Americans and citizens of the western world. The opportunity for technology to "trickle down" from defense to the consumer fields was enhanced by the fact that America was without peer in the world. Hence, the time necessary for technology to diffuse from defense application to consumer market was available. Today global competition has substantially reduced the time from technological innovation to consumer market. Competitive nations monitor innovations in technology and move developments rapidly into consumer products for worldwide markets.

There is little question that the world leadership today in science and technology remains largely in the United States. This is due in part to significant investments in research and development made by the federal government. Yet, the results of research and development conducted by the Department of Defense find no direct path into consumer product forms or into the development of embryonic new industries. Of course, national security requires that defense applications of technology be safeguarded. However, significant wealth in technology for consumer applications can be derived from basic research conducted by DOD without jeopardizing our defense requirements, while at the same time improving the position of America in global competition.

TRANSLATION OF DOD RESEARCH

Given the clear need to find new methods to take advantage of the significant national resources invested in research and development by the Department of Defense (DOD), it is timely to examine a single vehicle to translate this technology to the consumer identity sector. Consider the field of advanced composite materials which was initiated by DOD in 1965. The invention of continuous fibers which possessed strength and stiffness properties substantially superior to existing materials at significantly reduced densities, produced a new class of materials with revolutionary potential. Combining these fibers with polymeric matrices allows the designer a new degree of freedom - that of tailoring the material properties to the given requirements. By choice of composition and the arrangement of the fiber directions, the material properties may be adjusted to yield optimum characteristics. After over 20 years of research and development, these new material forms are virtually replacing conventional materials in military aircraft and missile applications. The Advanced Tactical Fighter (ATF) program projects that in excess of 50 percent of the airframe will be advanced composite materials.

The challenge facing the application of these new materials in commercial fields is the lack of manufacturing technology sufficient to achieve economy consistent with the competitive consumer markets. Today advanced composites applications in the

defense aerospace field are achieved through significant amounts of handwork requiring large manual work forces. Clearly, technology involving substantial amounts of labor intensive steps does not conform readily to the competitive attributes of this country in the global competition. Further, the variability of the product produced may be strongly influenced by the variability of the work force. Therefore, the expansion of this technology demands the development of automated manufacturing systems not only for economy of production in the commercial sector, but also, the reliability and reproducibility of defense systems requires that the manufacturing technology utilize methods which minimize product variability - namely, automated manufacturing systems.

There are of course at least two paths to the commercialization of ideas. The first involves an entrepreneurial advocate who pursues the reduction to practice of an idea by any means available. In the past, this has taken the form of the "garage shop"in the home of the entrepreneur. Notable examples of such an approach include Gore Associates, Inc. and Apple Computers, Inc., to name just two. Today, the modern entrepreneur may require incubator space located near a major university research center specializing in the appropriate fields of technology. When the idea has been reduced to practice, the commercialization venture may be financed through

venture capital organizations, through acquisition by an established industrial organization, or other financial mechanisms.

The second path to commercialization is completely inside existing industrial organizations. Here, the idea is reduced to practice and commercialized by the development and marketing elements within the organizations. Both these methods suffer deficiencies which may delay commercialization of new ideas. The entrepreneur may not have adequate technical support or cash flow to sustain development, while the established organization may be slow to act on worthy ideas due to the apparent risk when compared to existing product forms.

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Consider the establishment of an organization which will provide for the rapid commercialization of worthy ideas generated through research and development supported by the Department of Defense. Resources to support the organization may well be provided jointly by the local state, industry, university, the Department of Defense and other federal agencies. In addition to financial resources, human resources could be provided by the industrial sector and the university.

The concept of the Institute for Composites Manufacturing and Commercialization (ICMC) has been developed to respond to these needs. The Institute shown graphically in Figure 1 would include the Design and Innovation Center, the Manufacturing Pilot Plant Research And Development Center, the Facilities Bank for Equipment and Instrumentation, and Incubator Space. Ideas, financial resources, and human resources flow into the Institute from the local industrial sector, the state, the local university, the Department of Defense, and other federal agencies such as the National Science Foundation. In the Design and Innovation Center, modern computers and software are utilized by expert designers to complete concept designs. In the Manufacturing Pilot Plant Research and Development Center the manufacturing technology to produce the design is developed. Finally, equipment necessary to establish a small pilot plant is obtained from the Facilities Bank and established within the Incubator Space. After a suitable residence time within the Incubator Space, the new business is ready for designation as a commercial venture. It then moves to a new site and receives the additional investment required by venture capital organizations or is acquired by established industrial organizations.

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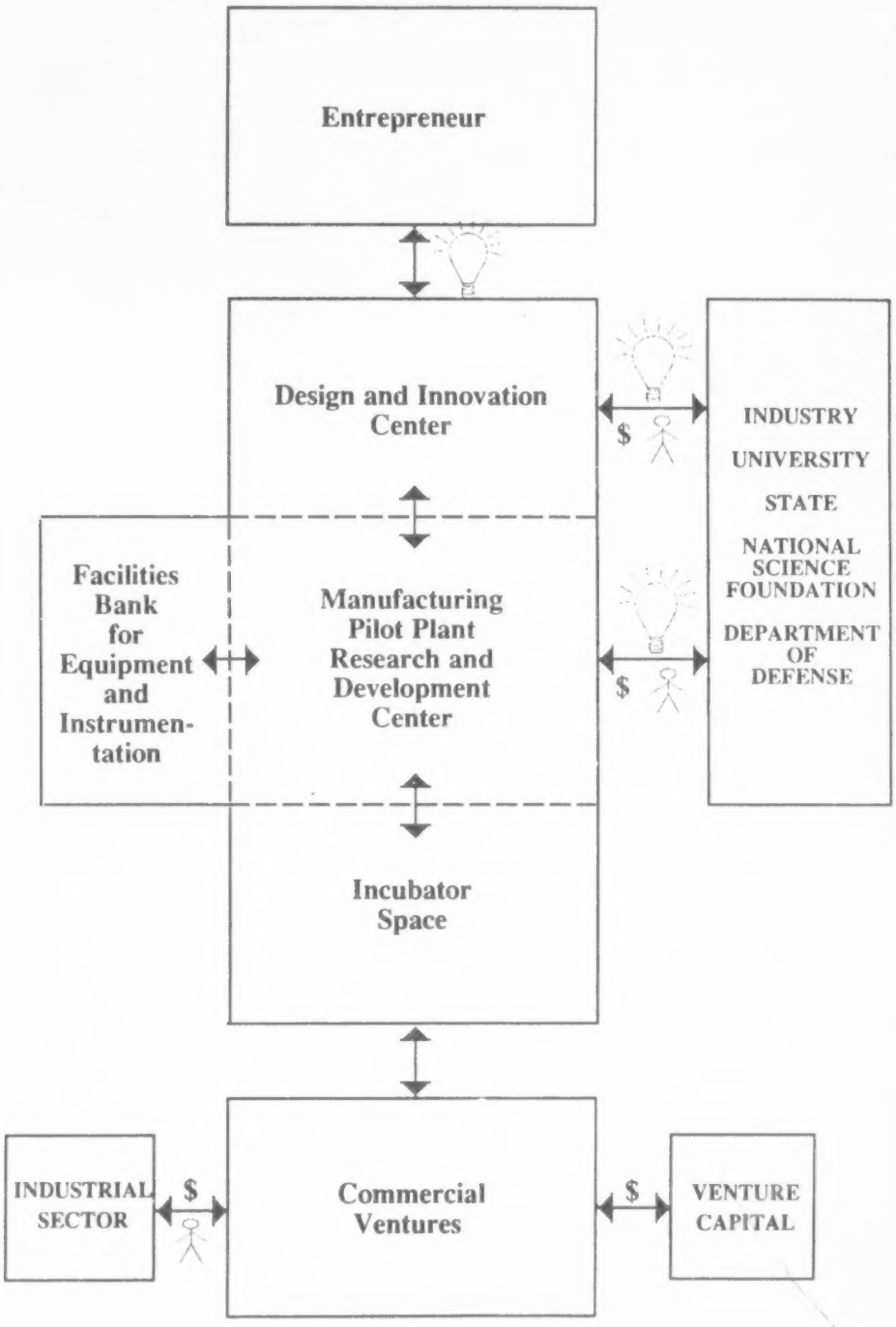
AND COMMERCIALIZATION



ICMC

VITA

PIPES, R. BYRON
Dean, College of Engineering
University of Delaware
Newark, DE 19716
Telephone: (302) 451-2401

Born: August 14, 1941

B.S. Louisiana Polytechnic Institute, 1964
M.S. Louisiana Polytechnic Institute, 1965
M.S.E. Princeton University, 1969
M.A. Princeton University, 1969
Ph.D. University of Texas, 1972

Publications:

Co-Author, Experimental Mechanics of Fiber-Reinforced Composite Materials, 1982, reprinted 1985
Co-Author, Experimental Characterization of Advanced Composite Materials, 1986.
Editor, Composite Materials, multivolume series, Elsevier - Applied Science 1986
Co-Editor, Application of Composite Materials in the Automotive Industry, 1978
Editor, Non-Destructive Evaluation and Flaw Criticality for Composite Materials, 1979
Author, over 40 publications in refereed journals

Editorial Activities:

Member, Editorial Board, Polymer Composites
Member, Editorial Board, Reinforced Plastics and Composites
Member, Editorial Board, International Journal of Composite Structures, 1982-present

Professional Activities:

Member, National Materials Advisory Board, 1980-86
Member, National Engineering Research Board, Materials Committee, 1984-85
Member, Advisory Panel, Office of Technology Assessment, U.S. Congress, 1983-84
Member, Panel for Materials Science, National Research Council, 1985-88
Member, Aeronautics & Space Engineering Board, NRC, 1985-86
Chairman, U.S. Air Force Forecast 2 Materials and Processibility Panel, 1985
Advisor to the Army Research Office in Composite Materials, NRC Committee, 1980-82
Technical Review Committee for the Air Force Composite Materials Design Guide
Member, NMAB, Committee, Characterization of Organic Matrix Composites, 1981-82
Chairman, NMAB Committee, Thermoplastic Composites for Structural Applications, 1985-present
Chairman, NMAB Committee on NDI of Metal Matrix Components, 1982-83
Chairman, ASTM Subcommittee D-30.02 Research and Mechanics, 1978-80
Member, American Society for Composites, 1985-present
Member, American Society of Mechanical Engineers
Member, Society of Experimental Mechanics, editorial committee for Experimental Mechanics, 1977-79
Member, Tau Beta Pi, National Engineering Honorary
Member, Pi Tau Sigma, National Mechanical Engineering Honorary
Member, Omicron Delta Kappa, National Scientific Research Society
Member, Sigma Xi, National Scientific Research Society

Awards:

Member, National Academy of Engineering, elected 1987.
Recipient, Gustus L. Larson Memorial Award of Pi Tau Sigma, 1983, ASME national award.
Recipient, Chaire Francqui, Distinguished Visiting Faculty Scholar, Catholic University of Louvain, Belgium 1984-85

Area of Expertise:

Academic administration, research in composite materials, manufacturing science, computer-aided design, finite element methods, composite structures, nondestructive evaluation, fracture and fatigue, and mechanical characterization.

Experience:

Dean, College of Engineering, University of Delaware, 1985-present
Director, NSF National Engineering Research Center, "Center for Composites Manufacturing Science and Engineering," University of Delaware and Rutgers University, 1985
Professor of Mechanical and Aerospace Engineering, University of Delaware, 1980-present
Director, Center for Composite Materials, University of Delaware, 1978-85
Acting Director, Center for Composite Materials, University of Delaware, 1977-78
Associate Professor, Mechanical and Aerospace Engineering, University of Delaware, 1974-80
Assistant Professor, Mechanical Engineering, Drexel University, 1972-74
Senior Structures Engineer, General Dynamics Corporation, 1969-72

Mr. McCURDY. Thank you, Dr. Pipes—very interesting proposal and we'll get to that in just a moment.

Mr. DeVault, I overlooked you earlier—I didn't mean to—to do that intentionally. Do you have a statement, or we'll welcome any testimony that you might have.

Mr. DEVAULT. I think Mr. Burns covered our position quite well. I guess I would just like to make one comment for the record, and that's in regard to the question posed to our friends from DOD earlier, and that regards to the—to the government's policy on domestic precursor. It's not a new issue. It's been around for five years. The idea got kicked off with Dr. Keyworth and Dr. DeLauria about five years ago. For five years the government has been wrestling with the issue of what should our policy be, and how do we implement it?

When DOD says, we have a policy—you're right, they do have a policy. Jim Wade signed a policy that said one-third should be domestic, but they don't have a plan to implement it.

This represents a very large investment from the materials community, because most of us are dependent upon a foreign source—ready to make this investment, but will not make it until we know what the implemenation plan is. You know, who is going to use this one-third so we can plan when those facilities come on board.

And if this committee can help in any way to bring a focus to that issue, I think that the materials industry would seriously appreciate it.

Mr. McCURDY. I appreciate your—your comment. The one area in Mr. Burns' statement that I underlined was on the PAN, and I—to be honest and I was not aware of the—exactly what the policy was either. And I sit on the Research and Development Subcommittee of Armed Services and know Dick DeLauri and others well. But I—I—I'm still not exactly clear as to what they have required of you. Are they saying that you shall make an investment, or that—that one-third of this material be produced domestically if you're to do business with the Federal Government, or what does it——

Mr. DEVAULT. Well, what their—what their policy—what they really say is that we're becoming very dependent upon graphite fiber as—as just about every weapon system has some—some percentage and growing. And they're very worried that we're—we don't have a—a total domestic capability. And the issues on raw material—polyacrylonitrile—they want to be totally domestically capability on some percentage of their off date. So they came up with a policy and said one-third. But they didn't say——

Mr. McCURDY. They wanted one-third.

Mr. DEVAULT [continuing]. What program, or when. Now, they did say 1988, but they didn't say what program. So we don't know whether we need to build that tomorrow because it's going to be an F-18, or we can wait two years because it's a V-22. There's no plan to implement the policy.

We are ready to put up the investment when it makes sense—when we know that it's time.

Mr. McCURDY. But by just saying it's one-third, if you are—basically they're telling as a government contractor, if you are con-

tracting on a given project, then one-third of the materials you produce—or that you manufacture, should be——

Mr. DEVAULT. No, they're going to say one-third of the DOD's usages, and they—they do have—they do plan to specify what program. Like, it doesn't—it may not make sense to go back and—and make a requirement of one-third of the F-18 be domestic, because the F—F-18's been in production for X number of years, and it would cost a significant amount of money to requalify.

The issue is what—one-third of the DOD usage must be com—domestic. Which third?

Mr. MCCURDY. Yeah. But who has the requirement, though, DOD or the contractor? The DOD does.

Mr. DEVAULT. DOD does.

Mr. MCCURDY. So, they're saying, internally we have to make a decision——

Mr. DEVAULT. They have to make a decision.

Mr. MCCURDY [continuing]. Of one-third that it should be.

Mr. DEVAULT. That's correct.

Mr. MCCURDY. In order to get there, they haven't said how they do that.

Mr. DEVAULT. That's right.

Mr. MCCURDY. And there is not a domestic producer?

Mr. DEVAULT. There is a domestic producer.

Mr. MCCURDY. Who is that?

Mr. DEVAULT. Union Carbide, which is now Amoco.

Mr. MCCURDY. And——

Mr. DEVAULT. They want more than one.

Mr. MCCURDY. How many foreign producers are there?

Mr. DEVAULT. Well, there are actually three major suppliers of graphite fiber in this country. It's Amoco, who used to be Union Carbide; and it's BASF, that used to be Celanese, and it's Hercules. Now, Hercules and BASF get their material from Japan—the raw material from Japan. Amoco makes it themselves.

But Amoco—if you take the programs they are qualified on—they cannot come near meeting the one-third DOD requirement. So that you must get another company qualified. One or more.

Mr. MCCURDY. Okay.

Well, I'm not sure this subcommittee can help you but perhaps the other subcommittee I'm on can look at this and probably will help me follow up with some more detail on that.

I appreciate the clarification there because, quite frankly, that's a new one to us. We have a hard enough time staying up with the aronyms, much less the known policy behind them all.

Dr. Pipes, the—first of all, I wanted to pursue one—one question on the University of Delaware. You are a NSF Center for Engineering Research and Composite Materials. Could you provide some—some detail as to the structure of that Center, its cost, number of staff, professors, staff and industry participation, et cetera?

Dr. PIPES. Mr. Chairman, thank you, I—I hadn't come prepared to talk about that in great——

Mr. DEVAULT. But you will. [Laughter.]

Dr. PIPES [continuing]. Detail but it's a—it's certainly a labor of love. I would have no problem giving you data.

The Center at the University of Delaware was established in 1974, and in 1978 it became a major industrially-funded—privately industrially-funded organization with, at that time, eight companies that were supporting it in a consortium. This was in some sense the precursor—one of the precursor programs to the National Science Foundation ERC Program.

By 1985, there were 35 companies that were supporting that. And we proposed to the National Science Foundation to become an ERC, expanding from the classic fields of basic research into manufacturing science.

So the new Center was founded as the National Center for Composites Manufacturing Science and Engineering. That was established in 1985.

You heard earlier that the URI program, of which you are one of the supporters, was advertised in 1986. The University of Delaware successfully competed—became the U.S. Army Center of Excellence in Manufacturing Science, Maintainability, and Reliability, moving the, if you will, the research thrusts beyond manufacturing into the reliability and maintainability issues, which are very interesting and important to the—to the U.S. Army.

Those programs taken together will yield about $5 million per year of external support into that activity. Some of that support, as I said, comes from the private sector, some from the National Science Foundation, some from the Department of Defense, and some from the State of Delaware.

There's a 30,000 square foot building being constructed to house this new activity at the University, which will be funded jointly by the State of Delaware and the private sector. It is funded fully and is coming out of the ground now.

We involve approximately 175 people. That does not translate to 175 man-years because those people—a large portion of them are students—approximately half are students, the other half are faculty and staff who are involved in the program. I believe it's 75 percent of our students. Let me change that number.

So it is a critical mass organization in place at this stage, and it addresses broadly the needs of the com—consumer sector and the defense industry simultaneously.

Mr. McCURDY. The—are you developing the actual machinery, or just the process? I mean, how—how do you integrate the two? Are you doing—I'm not exactly sure—when you're talking about developing——

Dr. PIPES. Mr. Chairman, neither are we.

This is—this is one of the dilemmas that one faces in working in the issue of manufacturing science. We—I think our charter is very clear—is to establish a science base for manufacturing.

But I expect to see some innovation coming from these young people, from these bright minds. I expect to see some new product forms and new manufacturing processes, and equipment, that will be coming from this venture.

Mr. McCURDY. Will this lead to a degree in material science? Are these mechanical engineers? Are these chemists? What—what is——

Dr. PIPES. These are engineers. And in—in our institution we give degrees in five disciplines—in civil engineering, the traditional

discipline; mechanical, chemical, electrical, and material science. And a student may pursue any one of those five degrees and access this technology, and be involved in it.

Mr. McCURDY. Is there any integration with the National Bureau of Standards automotive—Automated Manufacturing Program?

Dr. PIPES. There is no direct relationship with this program. And I failed to point out that there is an affiliation with Rutgers University in their ceramics engineering program through our National Science Foundation program. It is a joint program between Delaware and Rutgers.

We have no official organization or association with the National Bureau of Standards.

Mr. McCURDY. The—on the ICMC, how much do you think this will—would cost and what would you expect the source of financing to be if I should have to ask? And is cost sharing a—a key to the idea?

Dr. PIPES. Well, I think there's no question that cost-sharing is a key to the idea. There are a number of issues here that are important. I think the DO—protecting the DOD share of research and development by showing that it does in fact get to the consumer field is an important issue for the DOD itself. I think this—that this may be in some sense a—a—a protection position to take, to take a more proactive role in showing that DOD technology can, and does, and will—and I should underline will—get to the consumer product field.

But I would add that once that's in place, the manufacturing base that results, any manufacturing base that results, will reenter the defense establishment through its contractors and improved products, more reliable products, and the like. So I see a joint benefit to the DOD.

The consumer industry is obviously anxious to have investments made so that we can reduce these ideas to practice.

It is an extremely expensive undertaking to undertake manufacturing developments. Yet, if we don't do it as a Nation, I am convinced that we will be in the position you described earlier—in the titanium issue we will have two presses and our competitors will have an—a large number, and we will be trying to compete in that global scene, which will be a very difficult for our industrial sector.

So I think we—we need not only materials technology, which produces new material forms, but we need to get them to the marketplace in a—in a cost-effective way. And what we're doing now is not working, in my view, at the rate that it will need to work in order to continue our competitive advantage.

Obviously, it is working at some rate, and it is working in many places. But perhaps looking at the Japanese initiatives—the now new initiatives in Europe where there is a broader commitment, we find ourselves with a window of opportunity, which is open—but won't remain so very long. This is really our chance to continue our position.

Mr. McCURDY. Very good. Thank you.

Mr. Burns, you mentioned the propensity of the Department of Defense to classify materials, and Dr. Kerber indicated, however, there are only about 10 or 15 percent were actually in a classified arena.

Do you—do you concur with that position, or do you think there's a concern and overly—are they overly concerned about national security, and is there a tendency to—to be too restrictive?

Mr. BURNS. Well, I guess in my response I was talking about the programs on which the material is used, and the programs themselves being classified to the point where the materials supplier would have difficulty in understanding what the program is, and what the requirements are, that the material must meet. There are several programs like that in a—I guess in a classified way you could call the ATF a classified program, the ATA a classified program, and others.

So for materials suppliers, perhaps, that aren't part of that community, they would have a problem in becoming part of that community. There would be a problem there.

Mr. MCCURDY. So the problem is working up through the primes?

Mr. BURNS. The problem would be, from a materials supplier standpoint, penetrating that program so you can become a viable part of it. But I think in general those programs go out and look for the best technology that's available on industry, or within industry—they bring that technology in and then the suppliers start working with them to develop the needed materials.

As far as the percentage that are in that category program-wise, I suppose 10 to 15 percent might be a little low. Okay, in terms of volume of material that might be consumed on those programs.

Mr. MCCURDY. Actually, it's probably very low, if you're looking, you know, on specific programs. In ATA and ATF, I wrote the Conference Report on some of those requirements so I'm familiar with what—what they have, and I think your position better now.

Gentlemen, unfortunately, the—the hour has gotten late and I've got a couple people waiting. I appreciate very much your attendance today and your testimony, and your testimony in the record.

I would say that we would be willing again to—to look at the DoD issue on your—on your materials, and if there's some way we can assist there we can.

And, Dr. Pipes, again, I appreciate your coming down. You've made some interesting proposals and I'm sure that we'll continue to have a dialogue.

Thank you very much.

We stand adjourned.

[Whereupon, at 5:20 p.m., the subcommittee was adjourned.]

APPENDIX

Written Testimony To The U.S. House of Representatives
Subcommittee On Transportation, Aviation And Materials

Hearing On National Critical Materials Council
March 31, 1987
Room 2325 Rayburn

By

T.W. Longmire
Vice President and General Manager
Amoco Performance Products, Inc.

Advanced Materials

Mr. Chairman and Members of the Committee:

On behalf of Amoco Performance Products Inc. (APPI), I appreciate the opportunity to submit this written testimony for the subcommittee's consideration on the subject of advanced materials as part of the overview of the National Critical Materials Council.

Advanced materials are considered to include:

Advanced Composites
Structural Ceramics

Our remarks will cover only the first at this time. Our business is primarily in this area, although we do have an interest in the second.

We agree with the market estimates provided to you in previous testimony. U.S. consumption of PAN (polyacrylonitrile) carbon fiber can be expected to grow from four million pounds today to sixteen million pounds by 1995. Over $700 million of new capital investment must be installed by our industry to support this growth. It takes three years to design and construct a fully integrated fiber plant, one that manufactures PAN polymer, spins it into precursor fiber, and converts it by thermal processing to carbon fiber. Amoco's one million pound facility, located at Greenville, South Carolina, is the only fully integrated carbon fiber plant existent in the United States. There are currently no other facilities under construction.

Obviously, we are facing a severe shortage of a critical material. However, supply can be stimulated readily. We and others are willing to invest now, but we need implementation of the Department of Defense policy which requires one-third of the D.O.D.'s consumption to be sourced domestically by 1988 and one-half by 1990. The D.O.D. is rightly concerned about relying on foreign sources and long supply lines for a critical material from which billions of dollars worth of defense systems will be built. Unfortunately, the D.O.D. policy has not yet been implemented. Carbon fiber producers are unsure whether to build high investment, fully integrated plants, or low investment, conversion facilities which would utilize precursor fiber imported primarily from Japan.

A major barrier to implementation of the D.O.D. policy has been the confusing subject of material re-qualification costs. Such costs can be significant, if all production programs are included, but this is not necessary. The problem can be solved by selection of specific present and future production programs and by developing realistic qualification program requirements. In reality, the re-qualification costs are quite small compared to the risks involved and to the cost of individual system procurement.

There is a second important topic discussed in previous testimony with which we take exception. A change in the duty status of PAN fibers would only serve to encourage continued reliance on importation of a critical material. Additionally, the duty does not impact on the competitive position of U.S. producers versus foreign competition. Carbon fiber importers actually pay a higher duty fee in dollars per pound at the 5.6% rate than do importers of PAN precursor at the higher 10.2% rate because the value of carbon fiber is approximately four times that of PAN precursor fiber.

I very much appreciate the opportunity to submit these comments for your consideration and would be pleased to furnish any additional information you may require.

Sincerely,

T. W. Longmire

T.W. Longmire
Vice President/General Manager
Carbon Fibers and Advanced Composites
Amoco Performance Products, Inc.

TWL/pmb